M/T Tradewind Force

Facultat Nàutica de Barcelona
Degree: Complements de Formació
Course: Pràctiques en el vaixell
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Sea time period: From the 18th of April to the 19th of August 2012.
Professor: Juan Antonio Moreno Martínez

List of Contents:

PART 1: INTRODUCTION

General

The M/T Tradewind Force was under Time Charter with Guy Oil, trading in the following areas:

- Curacao – Georgetown – New Amsterdam

The cargo was loaded and stowed in ISLA Terminal, Willemstad, Curacao, The Netherland Antilles and discharges as per the charterer orders in both The Providence Terminal, Georgetown, Guyana or Berbice Terminal, New Amsterdam, Guyana.

figure 1: Map of the route with A: Curacao; B: George town; C: New Amsterdam

The round trip could be completed in 12 days, but unfortunately the call back into Curacao depended on the cargo orders, available jetty and terminal production. So the vessel was at the end of the round trip in stand-by in front of Curacao. Due to the unavailable anchorage, the vessel was forced to stand still and drift for several days during these periods of time.

The cargo loading and stowing plan was the following:

- Fuel Oil – COT 6 port and starboard
- MOGAS – COT 2 and 4 port and starboard, but at times COT 1 Port and Starboard
- Gas Oil – COT 3 and 5 port and starboard, but at times COT 1 port and starboard.
- Kerosene – COT 1 port and starboard

As a normal procedure lightering operation was avoided since coordination with 2nd officer for the safe passing draft into the river was done. Tides were always taken on count and the stowage plan was always prepared with the minimum possible safe draft.

REGISTERED OWNER : WILDEINEST INC.

Class Number : **9733417**
IMO Number : **9127710**

Owner/Manager Address
Registered Owning Company WILDEINEST INC.
Customer Number : 036633
Attention : ACCOUNTS PAYABLE,
Address :C/O ARIAS FABREGA & FABREGA16TH FLOOR, PLAZA 2000 BUILDING BOX 6307 Panama.

Managing Company
V. SHIPS USA LLC
Customer Number : 633752
Attention : ACCOUNTS PAYABLE,
Address : 1101 BRICKELL AVENUE SUITE 1500 Miami, FL, 33131, United States.

Billing Customer
V. SHIPS USA LLC
Customer Number : 633752
Attention : ACCOUNTS PAYABLE,
Address :
1101 BRICKELL AVENUE
SUITE 1500
Miami, FL, 33131, United States.

General Characteristics
Designation
Call Sign H9NT
Flag Name Republic of Panama
Port of Registration Panama
Keel Laying Date 11 Mar 1996
Delivery Date 29 Jul 1997
Categories
Description Double Hull Oil and Chemical Carrier
SOLAS CATEGORY Oil Tanker/Chemical Tanker
MARPOL CATEGORY Chemical Tanker
IBC IGC CATEGORY Type 1
ISM CATEGORY Oil Tanker/Chemical Tanker
Previous Names
Previous Name From 19 May 2002 Date To Date 29 Jan 2005
BUNGA MELAWIS DUA
Previous Flags
Previous Flags Port Name From Date To Date
Malaysia Port Kelang 19 May 2002 29 Jan 2005
ABS Class Notations
`+A1, Oil and Chemical Carrier, , @AMS, @ACC, VEC
ABS Notations
ESP, CRC

Service Limit

Unrestricted Service

MAIN CHARACTERISTICS

FLAG	Panamá
BUILT	1997/KOREA
CLASS	ABS
TYPE	Oil/Chemical IMO II
SPEED	11,5 Knots
DWT	8,622 Tons
GRT	6,373 Tons
NRT	2,550 Tons
LOA	116,6 mts.
BEAM	18,6 mts.
DEPTH	10,55 mts.
DRAFT	7,614 mts.
IMO NR.	9127170
CALL SIGN	H9NT
OWNERS	Wildeinest S. de R. L.
TECHNICAL MANAGERS	Vships USA
COMMERCIAL MANAGERS	Tradewind Tankers
HULL	Double Hull
BOW THRUSTER	NO

CARGO PUMPS

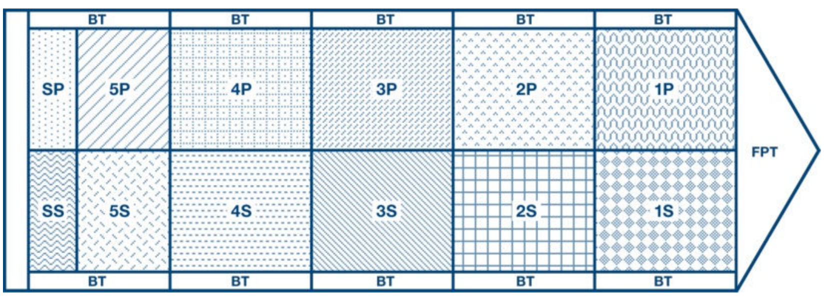
4 X 100 m³/hr
4 X 150 m³/hr
4 X 200 m³/hr
1 X 70 m³/hr PORTABLE
BALLAST 2 X 300 m³/hr

CARGO TANK CAPACITIES (98%)

Seg. # 1 COT 1P	412,788 m³
Seg. # 2 COT 1S	412,788 m³
Seg. # 3 COT 2P	717,492 m³
Seg. # 4 COT 2S	717,492 m³
Seg. # 5 COT 3P	1275,299 m³
Seg. # 6 COT 3S	1275,299 m³
Seg. # 7 COT 4P	818,512 m³
Seg. # 8 COT 4S	818,512 m³
Seg. # 9 COT 5P	1274,576 m³
Seg. # 10 COT 5S	1274,576 m³
SLOP TANK	637,969 m³
SBT	3752,278 m³

CARGO SYSTEM

TANKS	10
GRADES	10
COILS	YES
COATING	ZINC SILICATE
CAPACITY	8,997,2 m³
CRANE	1 X 5 Tons



Machinery

Propulsion System

MAIN ENGINE

Manufacturer Name : HHI ENGINE &

MACHINERY DIV.

Model Number : 6L35MC

Cylinder Bore: 350 mm Maximum Continuous

Rating:

3401.76 kW

Number of Cylinders: 6 Piston Stroke: 1050 mm

PROPELLER

Propeller Design Speed: 13 knots Propeller Material (ABS Grade): Bronze

Tail Shaft

Propeller Shaft Bearing Bearing Lubricant: Oil

PART 2: PRINCIPAL MACHINERY PARTICULARS - MAIN ENGINE AND AUXILIARY SYSTEMS

2.1 Main Engine

2.1.1 Main Engine Details

2.1.2 Main Engine Manoeuvring Control

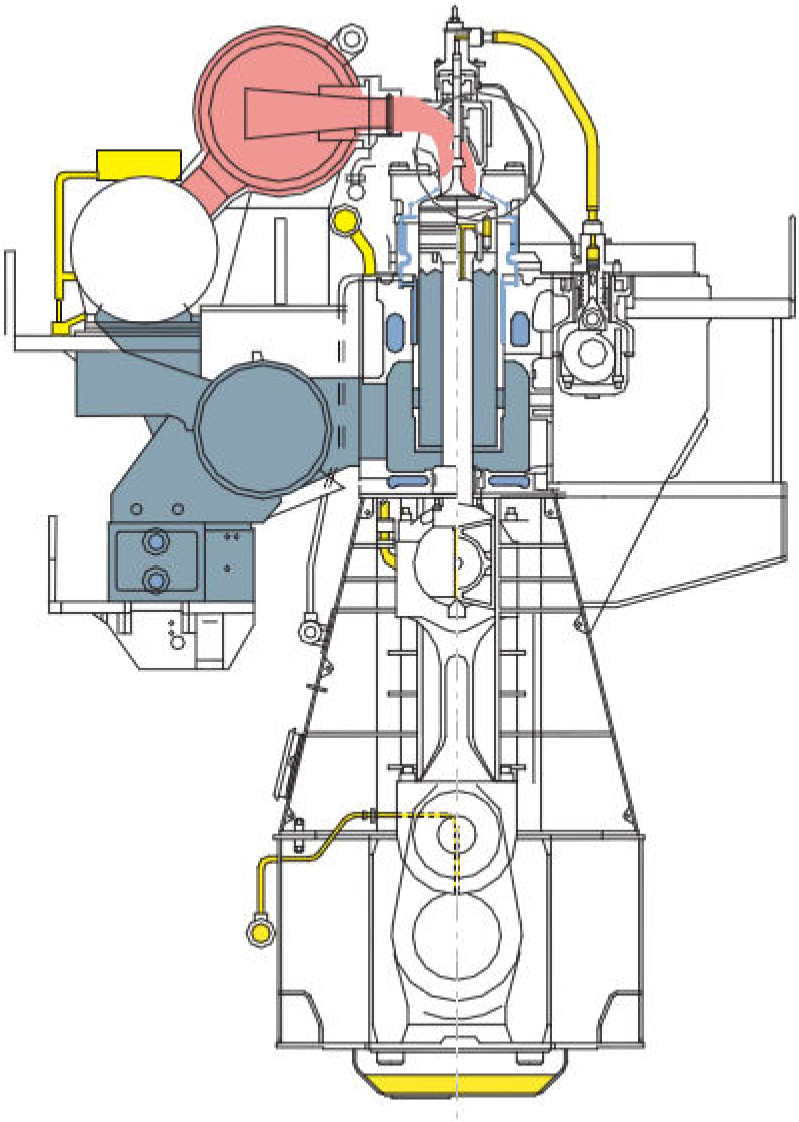
2.1.3 Main Engine Safety System

2.1.4 Digital Governor

2.1 MAIN ENGINE

2.1.1 MAIN ENGINE DETAILS

<table>
<tr><td colspan="2">Type</td><td colspan="2">Hyundai-MAN B&W, 2-stroke, single acting, direct reversible crosshead type diesel engine with constant pressure turbocharging</td></tr>
<tr><td colspan="2">Model</td><td colspan="2">Hyundai-MAN B&W MkVI</td></tr>
<tr><td colspan="2">Number of Cylinder</td><td colspan="2">6</td></tr>
<tr><td colspan="2">Cylinder bore</td><td>mm</td><td>350</td></tr>
<tr><td colspan="2">Stroke</td><td>mm</td><td>1,050</td></tr>
<tr><td rowspan="6">Max. Continuous rating (MCR)</td><td rowspan="2">Output</td><td>BHP</td><td>4,560</td></tr>
<tr><td>kW</td><td>3,354</td></tr>
<tr><td>Revolution</td><td>rpm</td><td>200</td></tr>
<tr><td>M.E.P.</td><td>bar</td><td>16.1 (16.4 kg/cm^2)</td></tr>
<tr><td>Max. pressure</td><td>bar</td><td>140~145 (142.8~147.9 kg/cm^2)</td></tr>
<tr><td>Mean piston speed</td><td>m/s</td><td>7.0</td></tr>
<tr><td rowspan="4">Continuous service rating (CSR)</td><td rowspan="2">Output</td><td>BHP</td><td>4,104</td></tr>
<tr><td>kW</td><td>3,019</td></tr>
<tr><td>Revolution</td><td>rpm</td><td>193.1</td></tr>
<tr><td>M.E.P.</td><td>bar</td><td>15.5 (15.8 kg/cm^2)</td></tr>
<tr><td colspan="2">Net weight dry</td><td>ton</td><td>65</td></tr>
<tr><td colspan="2">Direction of rotation</td><td colspan="2">Ahead: Clockwise, looking from aft</td></tr>
<tr><td rowspan="4">Cooling medium</td><td>Cylinder jacket</td><td colspan="2">Fresh water</td></tr>
<tr><td>Piston</td><td colspan="2">Lubricating oil</td></tr>
<tr><td>Turbocharger</td><td colspan="2">Non-cooling</td></tr>
<tr><td>Scav. air cooler</td><td colspan="2">Fresh water</td></tr>
<tr><td colspan="2">Starting system</td><td colspan="2">Compressed air (max.press. 30kg/cm^2)</td></tr>
<tr><td colspan="4">Remarks:
1. Net weight is dry basis and including flywheel, turbocharger(s), thrust bearing and turning gear, but excluding water and oil in the engine, spare parts and tools.
2. Dimensions and piston overhaul height are show separately in the drawings.
3. The above output is valid at sea level and up to tropical conditions,
Fresh water inlet temperature: 36 ºC
Blower inlet pressure: 1,000 mbar
Blower inlet temperature: 45 ºC</td></tr>
</table>



Introduction

The 6L35MC engine is a single acting, two-stroke, reversible, diesel engine of crosshead design with exhaust gas turbocharging and uniflow scavenging. Tie rods bind the bedplate, colums and cylinder jacket together. Crankcase and cylinder jackets are separated from each other by a partition, which incorporates the sealing gland boxes through which the piston rod pass. The cylinders and cylinder heads are fresh water cooled.

The exhaust gases flow from the cylinders through the hydraulically operated exhaust valve, which are fitted with small vanes on their spindles designed to make the valves rotate in service. The gases then pass into an exhaust gas manifold from where they then pass through a constant pressure turbocharger.

The charge air delivered by the turbocharger flows through an air cooler and water separator into the air receiver. It enters the cylinder, through the scavenge ports when the pistons are nearly at their bottom dead center (BDC) position. At low loads electrically driven auxiliary blowers boost the air supply to the scavenging air space.

The pistons are cooled by the bearing system lubricating oil. The thrust bearing and turning gear are situated at the engine's aft end. The camshaft is driven from the crankshaft by two chains, the chain drive being bolted to the side of the thrust collar.

Engine starting is by compressed air at 30kg/cm2 with the supply of this air to the cylinder being controlled by a starting air distributor.

The engine is also provided with an EGS 2000 electronic governor manufactured by Lyngso Marine. The speed setting of the actuator is determined by an electrical signal from the electronic governor which is based on the position of the main engine regulating handle. The actuator shaft is connected to the fuel regulating shaft by means of a mechanical linkage.

In case of failure of the remote control system, the engine can be controlled from an emergency control stand located at the engine side.

The engine camshaft consists of a number of sections. Each individual section consists of a shaft piece with exhaust valve cam, fuel pump cam, coupling parts and indicator cam. The exhaust cams and fuel cams are of steel, with a hardened roller race, and are shrunk on to the shaft. They can be adjusted and dismantled hydraulically. The camshaft bearings consists of one lower half shell mounted in a bearing support which is attached to the roller guide housing by means of hydraulically tightened studs.

The engine is also fitted with an axial vibration damper of the piston and split housing type which is mounted on the forward end of the crankshaft.

Lubricating Oil System

The engine lubrication system, with the exception of cylinder oil lubrication, is supplied by one of two main LO pumps rated at 335 m3/h and 4.5kg/cm2. These pumps take their suction from the engine's pump and supply oil to the main bearing manifold, piston cooling manifold, camshaft manifold and to each of the exhaust valve actuators. A branch on the discharge side of the pumps also supplies oil to the turbocharger bearings through system valve OL205F. When on LO pump is running the other is switched to standby for automatic start in the event of the discharge pressure of the operating pump falling to 3kg/cm2 or lower.

The oil temperature in the system is controlled by a water cooled LO cooler that regulates the oil entering the engine to 45º C. Oil contamination is controlled by an automatic backflush filter which the oil has to pass through before it is allowed to enter the engine.

Main and Crosshead Bearing Oil System

The main bearing system oil operates at a pressure of 4.5kg/cm2 supplied from the main LO pumps. The pipework is of steel construction with the oil being fed to each main bearing through branches from the main lubrication pipe located along the engine. Cooling oil is led to internal telescopic pipes through branches from the cooling oil main pipe located on the exhaust side of the engine. From here some of the oil is branched to the crosshead's shoes and bearings fro lubrication and to the underside of the piston crown for cooling.

The oil has good oxidation resistance and detergent properties with a viscosity grade of SAE 30.

The camshaft system is common with the main lubrication system and as such care must be taken to check that fuel oil contamination from leakage at the fuel injection pumps does not occur. Contamination here can degrade the properties of the system oil and as the oil from the cam boxes drains down through the engine to the main LO sump it can then mix and contaminate the rest of the system.

Turbocharger Bearing Oil

The turbocharger bearings are supplied with LO from a line branched off the main engine LO supply rail and as such the system is common with the rest of the main engine LO system. Because of the nature of turbochargers and the high speeds at which they spin, it is essential that the turbocharger bearings receive a plentiful supply of oil at all times to prevent bearing failure.

Oil return sight glasses are provided on each turbocharger bearing outlet to provide a visual indication of oil flow.

Cylinder Lubrication System

An Alpha cylinder lubrication system is fitted to the engine. This has a pump module which supplies pressure cylinder oil to the engine lubricator units which, in turn, direct measured quantities of cylinder oil to the cylinder lubricator quills. the system provides for timed injection of the cylinder oil in order to ensure the correct lubrication of the cylinder liners and piston rings.

Each cylinder has 6 lubrication quill connections mounted radially around the cylinder liner. Oil fed in first passes through a 30µ filter located at the 20 liter measuring tank outlet and then through a pressure filter on the outlet of the supply pumps; there are two pumps one of which is selected as the duty pump and the other as the standby pump. Once adjusted, the lubricators provide a feed rate proportional to the engine revolutions but the load dependant system automatically increases the oil in cases of sudden load change such as during manoeuvring or whilst in heavy seas.

The cylinder oil used is highly alkaline in its composition so as to neutralize the combustion acids created when burning heavy residual fuel oil. It has viscocity equating to SAE 50.

Cooling Water System

The main engine cooling consists of two systems. The high temperature (HT) system for the cylinders and exhaust valves and the low temperature (LT) system for the scavenge air coolers.

The HT system is a closed circuit system that supplies cooling water to the cylinders and exhaust valves and has its temperature controlled by a fresh water cooled jacket water cooler and FW generator whilst at sea. The LT system forms part of the engine room LT cooling system which has its central cooler supplied with se water cooling. The fresh water in both of the HT and LT engine systems are chemically treated with a nitrite-borate base inhibitor to prevent corrosive attack; sludge formation and scale deposits within the system.

Cooling Water System Description

The engine's high temperature cooling water is supplied by two jacket cooling water pumps, one operational and the other on standby. The water temperature leaving the engine is controlled at between 80 and 85º C by a three way valve that divers some water through the jacket water cooler and the remainder back to the jacket cooling water pump's suction. The amount of water passing through the cooler is load dependant but it is important to maintain the engine's temperature to avoid increased cylinder wear. A low cooling water temperature for example can cause condensation of sulfuric acid on the cylinder walls.

To prevent air accumulation in the cooling system, a dearating chamber has been incorporated in the pipework and this is connected with the HT fresh water expansion tank. The expansion tank is designed to allow for volumetric changes with temperature and make up for any system leakage. It is important that the concentration of corrosion inhibitor within the system is maintained to the manufacturer's requirements as untreated de-ionised water is relatively corrosive. The use of de-ionised water for cooling is preferred as it is free from limestone that can adhere to the cylinder liners and cylinder covers and restrict heat transfer.

The pH value of the cooling water should be maintained between 8.5 – 10.0 at 20ºC and the chloride content should not exceed 50ppm. A sudden decrease in the engine's pH value can indicate exhaust gas leakage while an increase in chlorine content can indicate salt water contamination.

The high temperature cooling water from the cooling water pump is fed to the engine's pipework and through branches to the cooling jacket on each cylinder. The water is led from the cooling jacket up through the cylinder cover and exhaust valve housing and from there to a manifold through which it is carried back to the fresh water cooler.

To prevent thermal stress to the engine's components, the cooling water outlet temperature should be maintained as steady as possible under all load conditions. The maximum fluctuations being $\pm$ 2ºC under constant loads and $\pm$ 4ºC during load changing conditions.

The low temperature cooling water is branched off the LT fresh water cooling system. The water passes through the scavenge air coolers and then returns back to the suction side of the central cooler fresh water pumps having first mixed with other returns in the circuit and passed through one of the two central coolers.

Fuel Oil System

Preheated fuel oil is delivered to the engine's injection pumps through a series of pumps, heaters, filter and a viscorator. A fuel circulating pump ensures a surplus of fuel is always available a the injection pumps. The fuel quantity delivered by the pump is greater than the required by the engine with the surplus being fed back to the system mixing unit, from which the pump takes its suction.

The main engine is designed to operate on heavy fuel oil during all normal conditions including manoeuvring. All pipes up to the high pressure fuel pumps on the engine are trace heated and insulated. The fuel is kept hot when the engine is at rest by circulating heated fuel oil from the circulating pump back to the fuel oil return pipe and hence back to the pump's suction manifold. For safety reasons, all high pressure lines from the engine driven fuel pump to the injectors are encased in a protective sheath. Leakage from a pipe will be detected by a collecting tank fitted with a high level alarm.

Fuel Pump and Fuel Oil High Pressure Pipes

The engines is provided with one fuel pump for each cylinder. The fuel pump consists of a pump housing, a centrally placed pump barrel, a plunger and a shock absorber. To prevent fuel oil from mixing with the lubrication system, the pump is provided with a asealing device arrangement. The pump is activated by the fuel cam and the volume injected is controlled by turning the plunger by means of a toothed rack connected to the regulating mechanism.

The fuel pumps incorporate Variable Injection Timing (VIT) for optimized fuel economy at part load. The VIT principle uses the fuel regulating shaft position controlling parameter. Adjustment of the pump lead is made by a threaded connection, operated by a toothed rack.

The fuel oil pump is provided with a puncture valve for each cylinder, which quickly prevents high pressure from building up during normal stopping and shut down. Activation of the puncture valve causes the fuel injection line pressure to drop and immediately frul injection ceases.

The fuel oil high-pressure pipes are equipped with protective hoses, and are neither heated nor insulated. Any leakage from the protective hoses is led to an alarmed collecting tank.

Starting Air System

The starting air system contains a main starting valve, a non-return valve, a bursting disc for the branch pipe to each cylinder, a starting air distributor and a starting valve on each cylinder. The main starting valve is connected with the manoeuvring system, which controls the start of the engine.

The starting air distributor regulates the supply of pilot control air to the starting valves so that these supply the engine cylinders with starting air in the correct firing order. The staring air distributor has one set of starting cams for ahead and on set for astern running, as well as one control valve for each cylinder. The air start valve is opened by pilot control air from the starting air distributor and is closed by a spring.

Scavenge Air System

The air intake to the turbocharger is direct fro the engine room through the intake silencer. The air is then led, via the charging air pipe, air cooler and scavenge air receiver to the scavenge prots of the cylinder liners. The charging air pipe between the turbocharger and the air cooler is provided with a compensator and is heat insulated on the outside.

Scavenge Air cooler

The scavenge air cooler is provided with a cleaning cover so that the elements can be cleaned with the elements in position. The cooler has an air reversing chamber with a water mist catcher incorporated to separate the condensation water from the scavenge air. The separated water is collected in the bottom of the cooler housing and removed by a drain. If not removed that water droplets would wipe the oil film from the cylinder liner surface as the savenge air moves upwards in the cylinder.

Exhaust Gas System

From the exhaust valves the gas is led to the exhaust gas receiver, where the fluctuating pressure from the individual cylinders is equalized and the total volume of gas is led to the turbocharger at a constant pressure. After the turbocharger, the gas is led to the exhaust gas boiler heat recovery system.

Compensators, to allow for thermal expansion, are fitted between the exhaust valves and the receiver and between the receiver and the turbocharger. Clamping bands are used for quick assembling and disassembling of the joints between the exhaust gas receiver an the exhaust valves. The exhaust gas receiver and exhaust pipes are provided with insulation, covered by galvanized steel sheeting.

This vessel is classified for ice operations and as such can expect to work in areas were the ambient temperature in the engine room can fall bellow 10ºC. Air temperature below this figure can begin to cause mechanical overloading of the main engine at full power gue to a higher air density resulting in higher scavenge pressure and hence higher combustion pressures due to the lower air temperature. To compensate for these lower air temperature, the exhaust manifold is fitted with a exhaust bypass valve which directs a proportion of the exhaust gas around the turbocharger therefore reducing the scavenge air pressure.

The system is designed to work automatically with sensor measuring the engine fuel pump index, scavenge air pressure, shaft torque and engine speed. This data is processed by a central processing unit which is separate from the main control and monitoring system and regulates the opening/closing of the bypass valve accordingly. The “electronic by-pass” system (EBP) control pane is situated on the main engine console in the CECR and indicates the valve % position. If necessary, the bypass valve can be operated in manual mode, although the makers manual must be consulted to ensure that the valve is maintained in the correct position according to the load on the engine and the resulting scavenge pressure. If the valve is opened too far, thermal damage can result, open too little can result in mechanical damage.

When the engine is shut down the valve will automatically go through an open and close cycle to ensure that valve seat is maintained clear of soot deposits.

Exhaust turbocharger

- Maker: ABB
- No. of sets: 1
- Type: 4872YK

A cleaning system is supplied for the turbine and compressor sides of the turbochargers. The turbocharger turbine is dry cleaned daily and the impeller is cleaned daily using water. Cleaning is carried out at full operating speed.

The turbocharger is equipped with an electromagnetic tachometer with a remote indicator being mounted in the engine control room.

Auxiliary Blower

- Maker: HIMCO
- No. of sets: 2
- Type: B&W Rear Type

The engine is provided with electrically-driven blower to supply additional air for optimum cylinder combustion during starting and when the engine is running a reduced loads. The discharge side of the blower is connected to the scavenge air space after the air cooler. Between the air cooler and the scavenge air receiver, non-return valves are fitted, which automatically close when the auxiliary blowers supply the air. The auxiliary blowers will start operating before the engine is started and will ensure sufficient scavenge air to obtain a safe start. During operation of the engine, the auxiliary blowers will start automatically each time the engine load is reduced to about 30-40%, and they will continue operating until the load again exceeds approximately 40-50%.

Un case where on of the auxiliary blowers is out of service, the other auxiliary blower will automatically compensate without any manual readjustment of the valves thus avoiding any engine load reduction.

The blowers should be started in sequence rather than at the same time due to the high starting current of the 90kW motors. The time delay between the starting of individual blowers is approximately 6 seconds.

Manoeuvering System

The engine is provided with a pneumatic electric manoeuvring and fuel oil regulating system. The system transmits order from the engine control room or the local control position at the side of the engine.

The regulating system makes it possible to start, stop and reverse the engine as well as control the engine speed. The speed control handle on the manoeuvring console gives a speed setting signal to the governor, dependent on the desired number of revolutions. At a shutdown function, the fuel injection is stipped by activating the puncture valves in the fuel pumps, independent of the speed control handle's position. Reversing is carried out by moving the telegraph handle from forward through the stop position and then selecting the astern desired speed. Control air then moves the starting air distributor and, through an air cylinder, the siplaceable roller in the drivng mechanism for the fuel pump, to the astern position.

Turning Gear and Turning Wheel

The turning wheel on the engine has cylindrical teeth and is fitted to the thrust shaft. The turning wheel is driven by a pinion on the terminal shaft of the turning gear, which is mounted on the bedplate. It is driven by an electric motor with built-in gear and chain drive with brake. It is also equipped with a blocking device to prevent the main engine from being started when the turning gear is engaged.

Engagement and disengagement of the turning gear is made manually by an axial movement of the pinion.

Oil Mist Detector

- Maker: Kidde Graviner
- No. of sets: 1
- Model: Graviner Mk6

The oil mist detector continuously scans the atmosphere at each engine crankcase. All units are scanned in sequence by sample points that are connected to a monitor unit.

It is essential that the oil mist detector is maintained in a full and effective operating condition and that any alarms are acted upon immediately as this instrument provides and essential safeguard against a crankcase explosion which can have extremely serious consequences.

Operating procedure

Preparations for Starting

Before starting the engine, the following checks and procedures are to be undertaken.

All components that have been overhauled are to be checked and wherever possible function tested.

All equipment, tools and rags used during overhaul are to be removed from the engine.

1.1. Air Systems

a. Remove the main engine turning gear.
b. Drain any water present from the control air system a the receivers and drain any water present from the starting air system.
c. Pressurize the air systems and ensure that the pressures are correct.
d. Ensure compressed air to pneumatic exhaust valves is available.
e. Engage the lifting/rotation check rod mounted on each exhaust valve and check that the exhaust valve are closed; these should be disengaged when lift/rotation is confirmed.

Note: Air pressure must be applied before the main lubricating oil pump is started. This is to prevent the exhaust valve from opening too far.

1.2 Lubricating Oil Systems

a. Check the oil levels in the main engine sump and replenish if necessary. Check that cylinder oil is available in sufficient quantity.

b. Start the main engine LO supply pumps

c. Ensure all oil pressures are correct

d. Ensure there is adequate oil flow through the return oil sight glasses for piston cooling and turbochargers.

e. Ensure the cylinder lubricators are filed with the correct type of oil and operate the cylinder lubricators manually to check that oil is being supplied by the pump units by pressing the Pre-lubrication pushbutton on the Alpha lubrication system.

1.3 Cooling Water Systems

a. Preheat the engine cooling water system to at least 50ºC but preferably to 75ºC

Note: The engine must not be started if the jacket cooling water temperature is below 50ªC

b. Start the high temperature central cooling system cooling water pumps.

c. Ensure the pressures are correct and that the system is not leaking.

1.4 Slow Turning the Engine

Slow turning of the engine must be carried out to prevent damage caused by fluid leaking into any of the cylinders and to test the air start system. Slow turning with the turning gear and cylinder cocks open enables any fluid in the cylinders to be detected. Before beginning this operation, permission from the bridge must be sought.

Note: Always carry out the slow-turning operation at the latest possible moment before starting and, under all circumstances, within 30 minutes of actually starting the engine.

1.4a Slow Turn the Engine with the Slow Turning System.

a. Disengage the turning gear.

b. Ensure that it is locked in the OUT position.

c. Check that the indicator lamp for TURNING GEAR ENGAGED extinguishes.

d. Ensure that starting air is available at the engine.

e. Open all of the cylinder indicator valves.

f. Select the SLOW TURNING operation by pressing the SLOW TURNING pushbutton.

g. Check to see if fluid flw out of any of the indicator valves.

h. If there is no hydraulic lock the slow turning system will complete one full revolution and when this has been achieved the engine is ready for starting.

i. The procedure is repeated with the engine turning in the opposite direction.

j. Close all of the cylinder indicator valves.

1.4b Slow Turn the Engine with Turning Gear

a. Open all of the cylinder indicator valves and engage the turning gear.

b. Turn the engine on revolution with the turning gear in the direction indicated by the reversing handle.

c. Check to see if fluid flows out of any of the indicator valves.

d. Repeat previous points in the opposite direction of rotation.

e. Close all of the cylinder indicator valves.

f. Disengage the turning gear.

g. Ensure the turning gear is locked in the OUT position.

h. Check that the indicator lamp for TURNING GEAR ENGAGED extinghishes.

1.5 Fuel Oil System

a. Start the fuel oil supply pump and circulating pump. If the engine was running on heavy fuel oil when stopped, the circulating pump should still be running.

b. Check fuel pressures and temperatures.

1.6 Checking the Fuel Regulating Gear

a. Close the shut-off valve of the starting air distributor to prevent the engine from turning. Check the indicator lamp.

b. Switch over engine control to the engine side control console.

c. Turn the regulating handwheel to increase the fuel pump index and check that all the fuel pumps follow to the FUEL SUPPLY position. With the regulating handwheel back in the STOP position, check that all the fuel pumps show zero index.

d. Switch back engine control to NORMAL

e. Open the shut-off valve to the starting air distributor.

f. Check that the indicator lamp estinguishes.

1.7 Miscellaneous

a. Switch on the electrical equipment in the control console.

b. Set the switch for the auxiliary blowers in the AUTO position.

c. The blowers will start at intervals of 6 seconds.

The engine is now ready to start.

Make the following checks immediately after starting:

. Direction of rotation: Ensure that the direction of rotation corresponds to the telegraph order.

. Check that all of the exhaust valves are operating correctly. Disengage the valve lifting/rotation indicators after checking that they are functioning.

. Ensure that the turbocharger is running correctly without abnormal noise or vibration.

. Check that all cylinders are firing.

. Feel over the pipes of the cylinder starting air lines. A hot pipe indicates a leaking air valve.

. Ensure that all pressures and temperatures are normal for the engine speed. In particular check the circulating oil (bearing lubrication and piston cooling), camshaft lubricating oil, turbocharger lubricating oil, fuel oil, cooling water, scavenge air and the control and safety air.

. Ensure that all of the cylinder lubricators are working and that eve flow to all cylinder injection valves is being obtained. Check the oil level in the feeder tank.

Loading the Engine

If there are no restrictions, such as running in after repairs, proceed to increase the load on the engine.

The cooling water should be preheated, but if the temperature is bellow 75ºC allow the temperature to reach this point before increasing load.

If the condition of the machinery is uncertain (e.g. after repairs or alterations), the “feel-over sequence” should always be followed, i. e.:

1. After 15-30 minutes` running on “Slow”
2. Again after 1 hour`s running.
3. At sea, after 1 hour`s running at service speed

Stop the engine, open the crankcase and feel over the moving parts listed below, by hand or with a “Thermo-Feel” on sliding surfaces where friction may have caused undue heating. During feeling-over, the turning gear must be engaged and the main starting valve and the starting air distributor must be blocked. The starting air distributor is blocked by closing the crossover valve.

Feel:

. The main, crankpin and crosshead bearings

. The piston rods and stuffing boxes

. The crosshead shoes

. The telescopic pipes

.The chains and bearings in the chain casing

.The camshaft bearing housings

.The thrust bearing/guide bearing

. The axial vibration damper

. The torsional vibration damper

Note: Care must be taken when opening up the crankcase for inspection and the crankcase doors must not be removed if there is any indication of overheating until the potential hot spot has cooled down.

Running-in

For a new engine, or after repair or renewal of the bearings, or renewal/reconditioning of cylinder liners and piston rings, allowance must be made for a running-in period. Increase the load slowly and apply the feel over sequence, as above.

Normal Operation

During normal running, regular checks have to be made and precautions taken which contribute towards trouble free operation. The most important of these are:

- Regular checks of pressures and temperatures
- The values read off the instruments compared with those given in the acceptance records and also taking into account engine speed and/or engine power, provide an excellent yardstick for estimating the engine performance. Compare temperatures by feeling the pipes. The essential readings are the load indicator position, turbocharger speed, charger air pressure and exhaust gas temperature before the turbine. A valuable criterion is also the daily fuel consumption, considering the low calorific value.
- Check all shut-off valves in the cooling and lubricating systems for correct position. The shut-offs for the cooling inlets and outlets on the engine must always be fully open in service. They serve only to cut off individual cylinder from the cooling water circuit during overhauls.
- When abnormally high or low temperatures are detected at a water outlet, the temperature must be brought to the prescribed normal value very gradually. Abrupt temperature changes may cause damage.
- The maximum permissible exhaust temperature at the turbocharger turbine inlet must not be exceeded.
- Check combustion by observing the color of the exhaust gases.
- Maintain the correct charge air temperature after the air cooler with the normal water flow. In principle, higher charger air temperature will result in

less oxygen in the cylinder, which in turn will result in a higher fuel consumption and higher exhaust gas temperatures.

- Check the charge air pressure drop across the air filter and air cooler. Excessive resistance will lead to a lack of air to the engine.
- The fuel oil has to be carefully filtered before being used. Open the drain cocks of all fuel tanks and fuel oil filters regularly for a short period to drain off any water or sludge, which may have collected there. Maintain the correct fuel oil pressure at the inlet to the fuel injection pumps. Adjust the pressure at the injection pump inlet with the pressure-regulating valve in the fuel oil return pip so that the fuel oil circulates within the system at the normal delivery capacity of the booster pump.
- The heavy fuel oil has to be sufficiently heated to ensure that its viscosity before inlet to the fuel injection pumps lies within the prescribed limits.
- Determine the cylinder lubricating oil consumption. Extended service experience will determine the optimum cylinder lubricating oil consumption.
- The cooling water pumps should be run at their normal operating point, if the actual delivery head corresponds with the designed value. If the pressure difference between inlet and outlet exceeds the desired value, pump overhaul should be considered.
- The vents at the uppermost points of the cooling water spaces must be kept closed.
- Check the level in all water and oil tanks, as well as all the drainage tanks of the leakage piping. Investigate any abnormal changes.
- Observe the condition of the cooling water. Check for oil contamination.
- Check the charge air receiver drain manifold’s sight glass to see if any water is draining away and if so, how much.
- Drain the scavenge spaces. To do this, open the drain cock of the leakage manifold daily and look to see if any liquid flows out along with the charge air.
- Check the pressure drop across the oil filters. Clean them if necessary.
- The temperature of the running gear should be checked by feeling the crankcase doors. Bearings, which have been overhauled or replaced, must be given special attention for some time after being put into normal service.
- Listening to the noise of the engine will reveal any irregularities.
- The power being develop by the cylinders should be checked regularly and fuel pumps adjusted as necessary in order to preserve cylinder power balance.
- Purify the lubricating oil. Samples should be taken at regular intervals.
- Replenish the air cushion in damping vessels of the fuel oil system.
- Check the exhaust valves are lifting and rotating. If not, the offending valve has to be overhauled at the next opportunity.

Fuel Changeover

The engine is equipped with uncooled fuel injection valves with built.in fuel circulation. This automatic circulation of the preheated fuel (through the high-pressure pipes and the fuel valves) during engine standstill allows for constant operation on heavy fuel. However, changeover to diesel oil can become necessary if the vessel is expected to have a prolonged inactive period with a cold engine, due to a docking or long stay in port.

A changeover can be performed during engine running or engine standstill.

It is very important to carefully follow the changeover procedures in order to prevent fuel pump and injector sticking/scuffing, poor combustion or fouling of the gas ways.

Changeover Procedure from Diesel Oil to Heavy Fuel Oil During Running

- Ensure that the HFO in the service tank is at normal temperature level.
- Reduce the engine load to 25-40% of MCR.
- By means of the thermostatic valve in the steam system, or by manual control of the viscosity regulator, heat the DO to a maximum of 60-80ºC to maintain its lubricating ability. This will minimize the risk of plunger scuffing and the consequent risk of sticking. To prevent gassing, this preheating should be regulated to give a temperature rise of about 2ºC per minute.

Due to the risk of sticking/scuffing of the fuel injection equipment, the temperature of the HFO in the service tank must not be more than 25ºC higher than the heated DO in the system (60-80ºC) at the time of changeover. The DO viscosity should not drop below 3cSt, as this might cause fuel pump and fuel valve scuffing, with the risk of sticking.

For more light diesel oils (gas oil), this will limit the upper temperature to somewhat below 80ºC.

- When 60-80ºC is reached, change to HFO by operating the three way valve OF208F and switch from DO to HFO. The temperature rise can then be continued at a rate of about 2ºC per minute, until reaching the required viscosity.

Changeover Procedure from Heavy Fuel Oil to Diesel Oil During Running.

- Preheat the DO in the service tank to about 50ºC, if possible.
- Close the steam supply to the fuel oil preheater and trace heating.
- Reduce the engine load to 25-40% of MCR load.
- Change to DO when the temperature of the HFO in the preheater has dropped to about 25ºC above the temperature in the DO service tank, but, not below 75ºC.

Note: If, after the changeover, the temperature at the preheater suddenly drops considerably, the transition must be moderated by supplying a little steam to the preheater, which now contains diesel oil.

Changeover Procedure from Heavy Fuel Oil to Diesel Oil During Standstill

- Stop the preheating. For temperature levels before changeover, see “Changeover from Heavy Fuel Oil to Diesel Oil During Running”.
- Change position of the three way valve OF208F from the HFO position to the DO position.
- Start the fuel oil supply pump (if not already running).
- The HFO will gradually be replaced by the DO in all of the supply an d spill return lines. Sufficient time should be allowed to elapse to ensure all HFO has been used and only DO is spilling back to the HFO service tank.
- Stop the fuel oil supply pumps.

Preparations Procedure Prior to Arrival in Port

- Decide whether the harbor manoeuvres should be carried out on DO or on HFO. Changeover should be carried out one hour before the first manoeuvres are expected.
- Start an additional generator engine to ensure a power service for manoeuvring and start the oil fired boiler.
- Make a main engine reversing test. This ensures that the starting valves and reversing mechanism are working.
- Blow off any condensed water from the starting and control air systems just before the manoeuvres.
- Stop the engine by setting the regulating lever to stop.

Operating Procedure, after Arrival in Port and the Finished with Engine Order has been Acknowledge in the Engine Room

- Switch over the engine room control
- Open the indicator valves
- Obtain turning permission from the bridge. Turn the engine on starting air in both directions.
- Switch off the auxiliary blowers.
- Test the cylinder starting air valves for leakage.
- Change to emergency control
- Activate the START button. This admits starting air, but not control air, to the starting valves.
- Check to see if air blows out from any of the indicator valves.
  If this event, the starting valve concerned is leaky. Replace or overhaul any defective starting valves.
- Lock the main starting valve in its lowest position by means of the locking plate.
- Close and vent the control air and safety air systems. Close the valve to the starting air distributor, shut off starting air and drain the starting air line.
- Wait a minimum of 15 minutes after stopping the engine before stopping the main engine LO sump. The LO is normally left running when in port unless work is undertaken in the crankcase, this helps prevent overheating of cooled surfaces in the

combustion chambers and counteracts the formation of carbon deposits in piston crowns.

- If the engine was run on HFO until stopped, keep the FO circulating pumps running and the FO preheated. The temperature may be reduced during the port stay. If the engine was run on DO, stop the FO pumps.
- Keep the engine preheated to minimum 50ºC, unless the harbor stay exceeds 5 days. This counteracts the corrosive attack on the cylinder liners during starting up.
- Switch off any equipment which does not need to operate during the engine standstill periods.

Crash Stop Procedure

When the ship's speed must be reduced quickly, the engine can be started in the opposite direction of rotation according to the following procedure. The procedure is valid for ECR control and emergency control from the engine local control position.

- a/ Acknowledge the telegraph.
- b/ Give the engine a STOP order.

Note: The engine will continue to rotate (at decreasing speed), because the velocity of the ship through the water drive the propeller and thereby turn the engine.

- c/ Check that the limiters in the governor are not cancelled.
- d/ When the engine speed has fallen to the reversing level of between 15 and 30% of MCR speed, give the REVERSING order and the give the START order.
- f/ When the start level is reached in the new direction of rotation (8-12% of MCR speed), give the order to run on fuel.

If the ship's speed is to high, the start level will not be reached quickly. This will cause a loss of starting air, in this case:

- g/ Give the STOP order.

Wait until the speed has fallen further then return to instruction d/. Keep the engine speed low for the first few minutest to reduce the hull vibrations that may occur owing to conflict between the wake and the propeller.

Fouling and Fires in the Scavenge Air Spaces

The principal cause of fouling is blow-by of combustion products between piston and cylinder into the scavenge air spaces. The fouling will be greater if there is incomplete combustion of the fuel injected.

Causes of poor combustion:

- The fuel injectors are not working correctly
- The fuel is at too low temperature
- Poorly adjusted injection pump timing
- Operation with a temporary shortage of air during extreme variations in engine loading and when the charge air pressure dependent fuel limiter in the governor is set to high.
- Charge air pressure dependent fuel limiter in the governor set too high.
- Overloading.
- Insufficient supply of air due to restricted engine room ventilation.
- Fouling of the air intake filters and diffuser on the air side of the turbocharger.
- Fouling of the exhaust gas boiler, the air cooler and of the scavenge ports.

Causes of blow-by of combustion products:

- Worn, sticking or broken piston rings
- Individual cylinder lubricating quills are not working.
- Damage to the running surface of the cylinder liners.
- Excessive liner wear or abnormal wear such as clover-leafing which can also result in ring collapse and loss of piston ring to liner seal.

If one or more of these operating conditions prevail, residues, mainly consisting of incompletely burnt fuel and cylinder lubricating oil, quill accumulate at the following points:

- Between piston rings and piston ring grooves
- On the piston skirts
- In the scavenge ports
- On the bottom of the cylinder jacket

Causes of the Fires

The blow-by of hot combustion gases and sparks, which have bypassed the piston rings between piston and cylinder liner running surface, enter the space on the piston underside and any residues present can ignite.

If there is afterburning of fuel in the cylinder due to late injection or poor fuel atomization, the cylinder pressure when the scavenge ports are uncovered, may be higher than the scavenge air pressure and hot combustion gases may enter the scavenge space.

A defective piston rod gland may allow oil from the crankcase to enter the scavenge space; the piston rod gland drains should be checked frequently for signs of crankcase system oil as this indicates defective gland sealing rings.

Indications of a Fire

- Sounding of the respective temperature alarms
- A considerable rise in the exhaust gas temperatures of the cylinder concerned and a general rise in charge air temperature
- The turbocharger may start surging

Fire Fighting Measures

The safety of shipboard personnel should be paramount whenever dealing with fires anywhere aboard ship.

- Inform the bridge of the situation
- Reduce engine power
- Cut out the fuel injection pump of the cylinder concerned
- Increase lubrication to the respective cylinder

If a serious fire occurs, shut down the engine after obtaining permission from the bridge and operate the fixed fire extinguishing system. This is achieved by opening valve ST251F on the 7.5kg/cm2 steam system.

A fire should have died down after 5 to 15 minutes. This can be verified by checking the exhaust gas temperatures and the temperatures of the doors to the scavenge space. Afterwards the engine must be stopped whenever possible and the cause of the fire established.

Checks should include:

- Cylinder liner running surface; piston and piston rings; air flaps in the receiver (to be replaced if necessary); possible leakage; piston rod gland; fuel injection nozzles.
- After a careful check or if necessary, repair, the engine can be put back on load with cut-in fuel injection pump and automatic cylinder lubrication.
- Should a stoppage of the engine not be feasible and the fire has died down, the fuel injection pump can again be cut in, the load increased slowly and the cylinder lubrication brought back again to the normal output. Avoid running for hours with considerably increased cylinder lubrication.

Preventive Measures

As can be seen from the causes, good engine maintenance goes a long way to safeguarding against fire in the scavenge air spaces. The following measures have a particularly favorable influence:

- Use of correctly spraying fuel injectors and keeping the air and gas passages clean.
- Optimum adjustment of the fuel cams and the fuel injection pump timing.
- If running continuously at low load, check the cylinder lubricating oil feed rate and adjust if necessary.

- The permanent residue drain from the piston underside must always be checked to prevent the accumulation of dirt ant the drain line cleaning valves used for cleaning the scavenge box drain line must be operated for a short time each day.

Preventive of Crankcase Explosions

The oil mist in the crankcase is inflammable over a very narrow range of mixture. Weaker or richer mixtures do not ignite. There must always be an extraneous cause to set off ignition, such as hot engine components. Only under these circumstances and the presence of a critical mixture ratio of oil mist and air can an explosion occur.

A hot spot is the common feature of all crankcase explosions and this can be due to metal-to-metal contact at a wiped bearing, rubbing guide, defective piston rod gland, damaged thrust, unlubricated gear wheel, etc. or even due to a prolonged scavenge fire. The hot spot provides the heat source to evaporate oil, which condenses to form mist-like droplets which will ignite readily, and ignite the mist. If the mist concentration in the crankcase reaches a critical level, and explosion can occur.

The engine is equipped with an oil mist detector which constantly monitors the intensity of oil mist in the crankcase and triggers an alarm if the mist exceeds the density limit.

Measures to be Taken when Oil Mist Alarm has Ocurred

- Ensure that the Oil Mist Detector alarm is genuine by operating the Test device.
- Do not stand near crankcase doors, relief valves or corridors near doors to the engine room casing.
- Reduce speed to slowdown level, if not already carried out automatically. Ask the bridge for permission to stop.
- When the engine STOP order is received, stop the engine. Close the fuel oil supply. Maintain engine cooling and lubrication as the supply of lubricant will assist the cooling of the hot spot.
- Switch off the auxiliary blowers.
- Open the stores hatch.
- Leave the engine room.
- Lock the casing doors and keep away from them.
- Prepare the firefighting equipment.
- Don not open the crankcase until at least 20 minutes after stopping the engine, ideally leave for as long as possible but if the interval is too long it may be difficult to detect the source of the hot spot; before any action is taken a check must be made to ensure that the oil mist detector alarm has gone out of the alarm condition. When opening up, keep clear of possible spurts of flame. Do not use naked lights and do not smoke.
- Stop the lubricating oil pumps. Open all of the lower doors on one side of the crankcase. Cut off the starting air, and engage the turning gear.

- Locate the “hot spot” using a infrared thermometer. Alternatively feel over by hand all the sliding surfaces (bearings, thrust bearing, piston rods, stuffing boxes, crossheads, telescopic pipes, chains, vibration dampers, moment compensators, etc.) Look for squeezed out bearing metal and discoloration caused by heat (blistered paint, burnt oil, oxidized steel). Keep possible bearing metal found at bottom of oil tray for later analysis. Prevent further hot spots bye preferably making a permanent repair. Ensure that the respective sliding surfaces are in good condition. Take special care to check that the circulating oil supply is in order. The engine should not be restarted until the cause of the hot spot has been located and rectified.
- Start the circulating oil pump and turn the engine by means of turning gear. Check the oil flow from all bearings, spray pipes and spray nozzles in the crankcase, chaincase and thrust bearing. Check for possible leakages from pistons or piston rods.
- Start the engine and after running for about 30 minutes stop and feel over. Check the sliding surfaces which caused the overheating and look for oil mist. There is possibility that the oil mist is due to atomization of the circulating oil, caused by a jet or air/gas, eg by combination of the following:

  Stuffing box leakages (not airtight)

  Blow-by through a cracked piston crown or piston rod (with direct connection to crankcase via the cooling oil outlet pipe).

An oil mist could also develop as a result of heat from a scavenge fire being transmitted down the piston rod or via the stuffing box. Hot air jets or flames may have passed through the stuffing box into the crankcase.

Shutdown Functions

Low lubricating oil pressure to main and thrust bearings

High thrust bearing temperature

Low lubricating oil inlet pressure to camshaft

Low lubricating oil inlet pressure to turbocharger

Engine overspeed

Slowdown Functions

LO temperature low

Piston cooling oil outlet temperature high

Piston cooling oil outlet no flow

Piston cooling oil outlet pressure low

LO to main and thrust bearings pressure low

2.2 Boilers and Steam Systems

2.2.1 General Description

2.2.2 Boiler Control Systems

2.2.3 Sootblowers

2.2.4 Medium Pressure Steam System

2.2.5 Low Pressure Steam System

2.2.6 Economiser

2.2 BOILERS AND STEAM SYSTEMS

2.2.1 GENERAL DESCRIPTION

The steam generating plant consists of two Aalborg auxiliary oil fired oilers and one exhaust gas economizer. The steam demand of the vessel in port is met by one or both of the boilers depending on the operating conditions at the time. At sea the steam demand is met by the exhaust gas economizer but this may be supplemented by one of the boilers in the event of high steam demand or low economizer output due to manoeuvring/slow steaming etc.

Auxiliary Boiler

- Maker: Aalborg Industries
- No. of sets: 2
- Type: Oil fired vertical smoke tube marine boiler
- Model: Mission OL model 25000
- Evaporation: 25,000kg/h
- Steam condition: 16.0/7.5kg/cm2 saturated steam at 203°C
- Feed water temperature: 90°C
- Fuel oil: HFO up to 700 cSt at 50ºC
- Atomising steam: 7.0kg/cm2

Auxiliary Boiler Description

The boilers are of the vertical, two-drum type, top-fired and equipped with a steam atomizing burner. The burner local control panel and all of the relevant boiler mountings are mounted on top of the boiler. The control system provides fully automatic operation of the boiler and the steam atomizing burner. The steam drum is cylindrical with two flat plates of equal thickness which are mutually connected by vertical solid stays. The steam drum is furnished with the necessary internal fittings to ensure an even distribution of the feed water and to ensure a sufficient dryness of steam. The burner cone in the furnace opening is an integrated part and so no refractory is provided in the top of the furnace. Manholes are placed in the steam and water drums, the drums having sufficient space for inspection and maintenance. Water drum design is similar to the steam drum, the water drum being located at the bottom of the boiler and connected to the steam drum by means of generating tubes and down comers.

The foundation the boiler consists of four supports, one as fixed foot and the others designed to allow for thermal expansion.

Both the furnace and the generating tube banks are located asymmetrically and are separated by the screen wall of vertical water tubes. Besides the screen wall the furnace consists of gas tight polygon shaped membrane walls. The water wall of tubes receives radiant heat from the combustion flame and this prevents burning of the boiler shell. The generating tube bank consists of vertical pintubes arranged in a staggered configuration, the pins acting to improve the heat conduction from the combustion gases to the water in the tubes. The flue gas passes through the deflected tubes at the bottom of the screen wall, and then upwards through the generating tube bank and out through the smoke outlet box. Downcomers connect the steam drum with the water drum and these promote water circulation.

The bottom tube plate is covered with a coat of insulation refractory and above that with a castable refractory.

Entry to the furnace is possible through the access door at the bottom of the furnace. Further inspection to the generating tubes is possible through the inspection door at the bottom of the furnace as well as the access door provided on the flue gas outlet box. Inspection of the generating tubes is also possible at the inspection door provided in the middle of the pin element section.

2.2.2 BOILER CONTROL SYSTEMS

Introduction

The boiler control system is designed to provide safe and functional operation of the auxiliary boiler plant both at the boiler side(s) and from the machinery console in the cargo and engine control room (ECR). There is a local control section for each boiler, a common power section and a PC based control and monitoring system in the ECR.

2.2.3 SOOTBLOWERS

Auxiliary Boiler Sootblowers

The auxiliary boilers are each provided with two sootblower units connected to a common steam supply. The sootblowers may be operated in LOCAL mode from the CECR engine control console or in REMOTE mode from the control cabinets located between the two boilers at the boiler tops. When operating the auxiliary boiler sootblowers the steam pressure must be the normal working pressure and the boiler should be on at least 50% load. Sootblowing takes place according to the timer setting module which is located in the control cabinets during continuous boiler operation. A conservative setting is every 8 hours.

Additionally, the sootblowers will operate 5 minutes after the first firing after a sea passage shut down when the economiser has been generating the steam capacity. During IG operations the sootblowers are interlocked out.

2.2.4 MEDIUM PRESSURE STEAM SYSTEM

Introduction

Saturated steam at 16kg/cm2 (medium pressure) is led from both of the auxiliary boilers into a common steam main. During normal sea going conditions the steam demand of the vessel is met by the exhaust gas economiser which operates at a pressure of 7.5kg/cm2. The saturated steam is branched off the main line at various points and is used to supply the following systems:

• Sootblowers for the auxiliary boilers and the exhaust gas economiser

• Steam atomisation for the auxiliary boiler fuel oil burners

• Cargo oil pump turbines and stripping pump

• Feed water filter tank heating system

• Reducing valves supplying the low pressure service systems at pressures of 7.5kg/cm2 for the engine room and 6.0kg/cm2 for the services on deck

• Steam dump to the cargo oil turbine vacuum condenser during inert gas topping up operations in order to maintain the load on the auxiliary boiler(s)

• During normal sea conditions dumping excess steam generated by the exhaust gas economiser to the atmospheric condenser

2.2.5 LOW PRESSURE STEAM SYSTEM

General Description

The low pressure steam systems are branched off the 16kg/cm2 system through reducing valves. The 6.0kg/cm2 system supplies the deck services and the 7.5kg/cm2 system supplies the engine room services; each system has its own reducing valve. This low pressure system provides all the necessary heating and general purpose steam services throughout the vessel.

2.2.6 ECONOMIZER

Exhaust Gas Economizer

- Maker: Kangrim Industries Ltd
- Type: Mono steam pressure exhaust gas economizer
- Model: EM15DD75A2
- Evaporation: 1,500kg/h
- Feedwater flow: 12m3/h
- Exhaust inlet temperature: 224°C
- Exhaust outlet temperature:196°C
- Feed water temperature: 80 - 85°C
- Steam condition: 7.5kg/cm2 saturated steam

Introduction

The mono steam pressure exhaust gas economizer is located at deck 2 level on the starboard side aft to take the waste heat from the main engine exhaust gas. It is normally operated in conjunction with the auxiliary boilers. When the economiser is operating, the on-line auxiliary boiler acts as a water and steam reservoir. One of the two boiler water circulating pumps takes water from the auxiliary boiler and circulates it through the economiser heating bank where some of the water is converted into steam. The mixture of steam and water flows to the steam drum of the on-line auxiliary boiler where the steam is separated for use in the steam system.

The economiser is of all welded construction, consisting of vertical registers of steel tubes with continuously welded spirally wound fins to improve heat transfer. The tube registers are located horizontally in the exhaust gas flow and are supported by columns and beams, which also support the inlet and outlet headers external to the gas flow.

The economiser generates steam due to the heat energy in the exhaust gas but at reduced engine loads or during periods of high steam demand it may be necessary to flash up one of the auxiliary boilers to supplement the heat energy available from the exhaust gas. It is normal practice to have one auxiliary boiler in economiser back up mode whilst the vessel is at sea to provide automatic firing of the boiler when required. At full main engine load, steam is generated at the maximum rate from the economiser but if this is in excess of the requirements of the ship, the excess is dumped to the atmospheric condenser through control valve ST001F.

The economiser is fitted with two motor driven steam type sootblowers, which are operated according to company policy and depending upon the operating conditions of the main engine. The sootblowers are controlled from the main or remote operation panel and can be operated in either manual or automatic mode. When in automatic the sequence is controlled by an adjustable timer but when switched to manual the operation can be started by pressing the startstop pushbutton. The sootblowers should only be operated when the engine is operating at full power. The operating medium for the sootblowers is saturated steam which is taken from the main steam range via isolating valve ST012F.

Sets of water washing nozzles are fitted to the upper casing of the economizer to allow water washing of the internals. They are stationary multi-nozzle type and are positioned to allow water spray to reach the whole of the internal area. The sprayers are also used in an emergency in the event of an uptake fire. Uptake fires are a phenomenon in which the soot accumulated on the internal surfaces catches fire and spreads to surrounding areas. If left unattended, the temperature rise can cause tube failure.

It is possible to operate the economiser in the dry condition in an emergency situation. When doing so, additional care must be taken to prevent the outbreak of soot fires as the risk increases due to the higher operating temperature on the tube surfaces. Before operation, the economiser must be water washed and during dry running, the use of the sootblowers should be increased to four times a day. Inlet and outlet temperatures need to be monitored and if the draught loss through the economiser increases, increase the level of sootblowing and reduce the exhaust gas inlet temperature to as low as possible.

In the case of tube failure, the economiser must be shut down and the failed tube repaired. In the event of the economiser having to be withdrawn from service and left dry, the operation is to be as described above.

2.3 Condensate and Feed Systems

2.3.1 Condensate System

2.3.2 Drains Systems

2.3.3 Boiler Feed Water System

2.3 CONDENSATE AND FEED SYSTEMS

2.3.1 CONDENSATE SYSTEM

Vacuum Condenser Condensate Pump

- Maker: Teikoku Machinery Works Ltd
- No. of sets: 2
- Type: V06E-AM
- Model: 200X100VCSE-AM
- Capacity: 50m3/h at 2.5kg/cm2 and 1,800 rpm

Vacuum Condenser Cooling Sea Water Pump

- Maker: Teikoku Machinery
- No. of sets: 1
- Type: TVD-A1M
- Model: 400TVD-A1M
- Capacity: 1,190m3/h at 9mth and 900 rpm

Turbine Drain Transfer Pump

- Maker: Shinko Industries Ltd
- No. of sets: 1
- Model: SB50

Vacuum Condenser

- Maker: Donghwa Entec
- No. of sets: 1
- Type: Tubular
- Model: DHCC-028786
- Capacity: 20,375,000kcal/h

Atmospheric Condenser

- Maker: Donghwa Entec
- No. of sets: 1
- Type: Tubular
- Model: DHCC-028765
- Capacity: 2,110,000kcal/h

Introduction

The steam condensate system is part of the steam generating cycle and is the section concerned with the circulation of boiler feed water from the vacuum and atmospheric condensers back to the auxiliary boilers and the exhaust gas economiser.

Exhaust steam from the cargo pump turbines (COPTs) is condensed under vacuum in the sea water cooled vacuum condenser with the cooling water being supplied by the vacuum condenser cooling sea water pump. The vacuum in the condenser is maintained by the air ejector. The water level in the condenser is maintained by a three-way automatic level control valve which discharges condensate to the feed filter tank but also returns condensate back to the vacuum condenser to maintain a minimum level and so ensures the condensate pump maintains suction.

The collected condensate is transferred by one of the two condensate pumps, to the feed filter tank. The level in this tank is maintained by adding makeup water from the distilled water tanks via a flow meter and a level control valve. The condensate condition is continuously monitored by a salinometer, situated at the bottom of the vacuum condenser, which activates an alarm if high salinity is detected.

A separate 0.5m3 turbine drain tank collects the drains from the three cargo pump turbines and the condensate in this tank is pumped to the feed filter tank supply line by means of the turbine drain transfer pump. The pump is selected for automatic operation, starting and stopping by means of tank high and low level switches. The pump discharge non-return valve SD207F is normally left open.

The discharge head pressure is maintained on the condensate return to the feed filter tank by a non-return pressure control valve SD014F. Exhaust steam from the exhaust gas economiser steam dump line and other steam drains systems is condensed in the atmospheric condenser which is cooled by water from the low temperature central cooling fresh water system.

Supplementary heating of the feed filter tank comes from a heating nozzle fed into the tank from the 7.5kg/cm2 steam range. Steam heating is applied to make-up feed by means of a steam line to the degassing chamber into which the make-up feed is directed.

The condensate level in the atmospheric condenser is maintained by means of a weir with excess condensate flowing over a weir to the outlet line. This then flows to the feed filter tank via an inspection tank. Condensate flowing through the inspection tank is monitored for hydrocarbon contamination by an oil detection system and if any contamination is detected an alarm sounds allowing the contaminated returns in the inspection tank to be manually diverted to the bilge primary tank through valve SD005F. The inspection tank sections can be fully drained to the bilge primary tank through valves SD008F and SD009F. A siphon tube in the inspection tank outlet to the feed filter tank reduces the risk of any oil being carried over into the feed system. The filter tank has a low level alarm and can also be fully drained to the bilge primary tank through valve SD010F.

Water from the feed filter tank provides the feed water pumps with a positive inlet head at the pump suctions. The condensate outlet temperature from the atmospheric condenser should be maintained at 80°C.

The feed filter tank is fitted with a recirculation pump for degassing the feed water. The pump takes suction from the discharge section of the feed tank and directs the water to the degassing column of the feed tank. This enables air to be removed from the water due to a prolonged stay in the feed tank at high temperature.

2.3.2 DRAINS SYSTEM

Introduction

Condensate from the auxiliary steam services is returned to the feed filter tank, through a fresh water cooled drains cooler called the the atmospheric condenser and an inspection tank. As there is a possibility of contamination from leaking heating coils inside fuel oil tanks or various system heat exchangers, the condensate drains are segregated and checked in the inspection tank before they are allowed to return to the system in the feed filter tank.

Steam supplied for heating purposes to a heater element or trace heating line gives up maximum heat when it condenses back to water and the aim of any heating system of this type is to ensure that only condensed steam (condensate) returns to the atmospheric condenser which, therefore, acts as a drain cooler.

All drains outlets from heating lines are fitted with a drain trap which only lets water pass and therefore keeps the steam in the heating line until it has condensed. The drain traps are normally provided with inlet and outlet valves and also with a bypass valve to allow the heater to remain in operation even if the drain trap becomes defective. A defective drain trap is indicated by steam returning to the atmospheric condenser and the defective drain trap can be traced by the fact that its return line will be abnormally hot as it will contain steam. If a drain trap has to be bypassed for maintenance purposes, the bypass valve should be throttled so as to restrict the passage of steam.

2.3.3 BOILER FEED WATER SYSTEM

Boiler Feed Water Pump

- Maker: Teikoku Machinery
- No. of sets: 3
- Type: Horizontal centrifugal
- Model: 100-2SLM
- Capacity: 30m3/h at 23.5kg/cm2

Exhaust Gas Economiser Feed Water Pump

- Maker: Teikoku Machinery
- No. of sets: 2
- Type: Horizontal centrifugal
- Model: 50-4SLM
- Capacity: 4.0m3/h at 23.5kg/cm2

Boiler Water Circulating Pump

- Maker: Allweiler AG
- No. of sets: 2
- Type: Horizontal centrifugal
- Model: 50BF-AWM
- Capacity: 12m3/h at 3.5kg/cm2

Introduction

The boiler feed system is the section of the steam generating plant which circulates feed water from the feed filter tank into the steam drum of the boiler via the boiler feed water pumps and the feed water regulators. The feed water flow to each boiler is automatically controlled by the feed water regulating valves, in accordance with the variation in water level in the steam drum and the boiler steam outlet flow signal. There are high and low demand automatic feed regulator valves for each boiler, the low demand regulator operates initially when the feed requirement is between 0 and 40%, after this valve the high demand regulator begins to operate in conjunction with the low demand regulator. In addition to these feed regulating valves, there is an auxiliary feed line to each boiler which has a manually operated regulator valve.

Three boiler feed pumps take suction from the feed filter tank, each is capable of supplying the boilers at a rate of 30m3/h against a pressure of 23.5kg/cm2.

These feed pumps are designed to supply the boilers during cargo operations or at other times when the oil fired boilers are in use.

The economiser feed pumps are designed to supply the boiler's needs during normal sea going conditions when only the exhaust gas economiser is on line supplying the 'at sea' steam demand. Two economiser feed pumps are provided and they take suction from the feed filter tank. Each can supply the duty auxiliary boiler at a rate of 4m3/h against a pressure of 23.5kg/cm2.

The economiser is supplied with feed water from the main boilers via the boiler water circulating pumps which are each rated at 12m3/h.

When only the economiser is producing steam, one of the economiser feed pumps will be operating and the other will be on standby. There is no direct connection from the economiser feed pumps to the economiser as the feed water is supplied to the auxiliary boilers. One of the two available boiler water circulating pumps takes water from the water drum of the duty boiler and supplies it to the bottom of the economiser. As the water rises through the economiser and receives energy from the exhaust gases it is converted into a mixture of saturated steam and water. The combined mix then returns to the steam drum of the duty boiler where the water is separated out. As the economiser is using the same water as is used in the main steam generating plant, there is no need to supply a separate chemical treatment inlet.

Each main boiler and economiser feed pump returns a small proportion of the discharge back to the feed filter tank through an orifice; this prevents the pump from overheating whenever the feed water regulator is closed due to the boiler or economiser being on low load. If the steam demand falls for any reason, such as when a cargo pump is stopped, the feed water regulator automatically shuts the feed valve to the boiler, but the feed pump(s) still operate normally.

Without feed water delivery, overheating of the feed pump(s) could quickly occur.

Feed water is normally supplied to each boiler through feed water regulators, one per boiler, but it can also be supplied through a separate auxiliary line which can be used in an emergency. The main feed pumps are organised with one or two units in operation and another acting as standby. The standby pump will cut in on the failure of a running unit(s). Normally only one feed pump is required for the economiser and the other is set for standby operation. In each case the standby feed pump cuts in at a pressure of 22kg/cm2.

Boiler water chemical treatment is administered by injecting chemicals, from the dosing unit, directly into the feed pump suction line using a chemical dosing unit.

2.4 SEA WATER SYSTEMS

2.4.1 MAIN AND AUXILIARY SEA WATER SYSTEMS

Main Cooling System Sea Water Pumps

- Maker: Teikaky Machinery Works Ltd.
- No. of sets: 2
- Model: 350TVD-Alm
- Type: Self-priming, vertical, centrifugal
- Capacity: 840m3/h at 1.8kg/cm3
- Motor: 65kW at 1,800 rpm

Introduction

Main Sea Water Cooling System

Sea water is circulated through the central fresh water coolers by one or both of the main SW cooling pumps. Under normal seagoing conditions one pump should provide sufficient cooling water to maintain correct system operating temperatures, but, under certain circumstances such as high sea water temperature, it may be necessary to start the second pump. With one pump running and the other pump set to standby it will cut in should the system pressure fall below 1.3 kg/cm2.

Conversely, with this vessel being classified as an ice class ship which is able to operate in freezing water climates, a 350mm recirculation line is fitted on the overboard discharge line from the central coolers and evaporator which leads back to the low sea suction on the starboard side. In very cold sea water temperatures, this line allows sea water to be fully or partially recirculated back to the starboard low sea chest in order to reduce the thermal gradient across the sea water side of the central coolers. This would be manually achieved by throttling in on the overboard discharge valve WS025F and opening up on the sea water return valve WS107F to the sea chest.

The recirculation valve WS107F is operated remotely from an independent hydraulic deck stand valve on the 3rd deck starboard forward. Additionally, this valve can also be operated manually via an extended spindle at the floor plate level when the manual drive key is inserted into the drive shaft and the changeover lever on the top of the valve is turned to the correct position bypassing the operating piston.

Due care and attention must be paid to the back pressure both on the central cooler and the outlet from the evaporator when recirculation is in operation.

Additionally, attention must be paid to the salinity of the circulating water when the evaporator I in operation if on full recirculation, as this could have a detrimental effect on the cooler surfaces with increased scale formation on the heat transfer plates both on the central cooler and in the evaporator.

The main sea water circulating pumps can also be configured to supply cooling water to the vacuum condenser. This is achieved by opening valve WS019F and would be used in the event of a failure of the vacuum cooling sea water pump.

Water from the SW pumps is also bled off to supply the Marine Growth Prevention System (MGPS) which provides protection to the two sea chest water inlets. After passing through the fresh water coolers the water from the SW pumps is discharged overboard through valves WS024F and WS025F.

When the Cargo Oil Pump Turbine (COPT) pumps are operating, it is necessary to operate the COPT vacuum condenser. The cooling water to this is supplied by the vacuum condenser sea water cooling pump. There is only one pump fitted but should this fail, cooling water can be supplied by the main SW cooling pumps. A 'no flow' alarm is fitted to the sea water line for the vacuum condenser. If the pressure in the vacuum condenser rises the cargo oil pump turbines will be tripped at a back pressure of 0.7kg/cm2, additionally, the steam dumping will stop if the 'no flow' alarm is raised.

All of the pumps described take suction from a common sea water line connected to the high and low sea chest suctions. Valves WS001F and WS005F control the high sea chest and valves WS002F and WS006F control the low sea chest. The low suction is normally used at sea or when surface contamination such as weed or slush ice is present. It is also used when the ship is in light ballast conditions when the ingress of air is possible. The high suction is used when the ship is operating in silted or shallow waters to avoid the ingress of sand or silt into the cooling system. Suction strainers are fitted at both sea chests and a steam connection is provided for the clearing of ice and weed. Both of the ship's side suction valves, WS001F and WS002F, are remotely operated from a hydraulic power pack located on the engine room 2nd deck. Each valve can also be operated from a local hydraulic handwheel unit located at the floor level.

The cooling SW pumps can be started and stopped either locally from the starter adjacent to the pumps or remotely from the engine control room. The standby pump is designed to cut in automatically on low system pressure.

The No.2 SW cooling water pump can also be used in an emergency to pump the engine room bilges. It is a self-priming pump and has a 350mm suction line branched off to the emergency bilge suction. It is operated by opening valve BG019F which has an extended spindle taking the valve handle to a height of at least 460mm above the lower floor plate level.

Fresh Water Generator

The fresh water (FW) generator is supplied by its own dedicated ejector pump which takes suction from the sea water suction main. Should the FW generator ejector pump fail, a supply can be maintained from the Bilge, Fire and General Service Pump.

Operation of the Main Cooling Sea Water System

Preparation for the operation of the main cooling se water system.

a- Ensure that the sea chest suction strainers are clean
b- Ensure that all pressure gauge and instrumentation valves are open and that instruments are functioning correctly. Also check that the drain valves on the two central coolers are closed.
c- Set up the valves as shown in the tables below. In this case it has been assumed that the low sea suction is in use and that only on of the central coolers is in operation with the other being held as a clean standby unit, and that no recirculation is required due to cold sea water temperatures.

Position	Description	Valve
Open	Low suction ship's side valve	WS002F
Open	Low suction strainer outlet valve	WS006F
Closed	Low suction strainer drain valve	
Closed	High suction ship's side valve	WS001F
Open	High suction strainer outlet valve	WS005F
Closed	High suction strainer drain valve	
Closed	Recirculation valve to low sea chest	WS107F
Open	No.1 main cooling SW pump suction valve	WS013F
Open	No.1 main cooling SW pump discharge valve	WS017F
Open	No.2 main cooling SW pump suction valve	WS014F
Open	No.2 main cooling SW pump discharge valve	WS016F
Closed	Crossover valve to vacuum condenser line	WS019F
Closed	Emergency bilge suction from No.2 SW pump	BG019F
Open	No.1 central FW cooler inlet valve	WS020F
Open	No.1 central FW cooler outlet valve	WS022F
Closed	No.1 central FW cooler backflush valve	WS054F
Closed	No.2 central FW cooler inlet valve	WS021F
Closed	No.2 central FW cooler outlet valve	WS023F
Closed	No.2 central FW cooler backflush valve	WS055F
Open	Central coolers overboard discharge valve	WS025F

d- Start the duty main SW pump(s) and place the standby pump on automatic cut-in.
e- Vent the in-use central FW cooler and check that water is circulating through the central cooler and that the flow is adequate for the cooling load.

Note: The coolers may be backflushed to remove debris from the cooler surfaces and hence improve the cooling efficiency. This will normally be undertaken when the cooler is not under load. The inlet and outlet se water valve are closed and a se water hose is connected to the backflushing connection. The inlet line filter blank is removed and a drain hose connected; the backflushing valve is opened allowing se water to flow back through the cooler dislodging sediment.

Preparation for the Operation of the Vacuum Condenser Sea Water System

a- Ensure that one of the sea suction connections is open as described in the procedure for the main sea water circulating system.
b- Ensure that all pressure gauge and instrumentation valves are open and the instruments are reading correctly.
c- Set up the valves as shown in the table below.

Position	Description	Valve
Open	Vacuum condenser SW pump suction valve	WS032F
Open	Vacuum condenser SW pump discharge valve	WS034F
Closed	Cross over valve to vacuum condenser line	WS019F
Open	Vacuum condenser overboard discharge valve	WS035F

Note: The vacuum condenser overboard discharge valve WS035F is operated from the local hydraulic manual stand, WS103F at floor level or from the remote hydraulic unit on the engine room 2nd deck level.

d- Start the vacuum condenser sea water pump. It will then be possible to commence raising the vacuum using the air ejector unit which is cooled from the LT fresh water cooling system.
e- Check that a vacuum is established in the vacuum condenser.

Procedure for the Operation of the Fresh Water Generator Pump

a- Ensure that one of the sea suction connections is open as described in the procedure for the main sea water circulation system.
b- Ensures that all pressure gauge and instrumentation valve are open and that instruments are reading correctly.
c- Set up the valves as shown in the table below.

Position	Description	Valve
Open	FW generator ejector pump suction valve	WS036F
Open	FW generator ejector pump discharge valve	WS037F
Closed	Crossover valve from bilge, fire a	WS049F
Open	Fresh water generator brine outlet valve	WS038F
Open	Overboard discharge valve	WS025F

d- Start the FW generator in accordance with procedures described in section 2.4.3 of this report.

Procedure for the Operation of the Marine Growth Prevention System Pump a- Ensure that one of the main cooling sea water pumps is operating as described above.

b- Ensure that all pressure gauge and instrumentation valves are open and that instruments are reading correctly.

c- Set up valves as shown in the table below.

Position	**Description**	**Valve**
Open	MGPS unit sea water supply valve	WS026F
Open	MGPS unit sea water inlet valve	WS027F
Open/closed	MGPS outlet valve to high sea suction chest	WS028F
Open/closed	MGPS inlet valve at the high sea suction chest	WS030F
Open/closed	MGPS outlet valve to low sea suction chest	WS029F
Open/closed	MGPS inlet valve at the low sea suction chest	WS031F

d- Operate the sea water systems as required.

Note: The MGPS valves to the sea suction chests will normally be left open at all times when the sea suction system is operational.

2.4.2 SEA WATER GENERAL SERVICE SYSTEM

The engine room auxiliary sea water service are supplied by the following pumps:

- Bilge, Fire and GS pump
- Fire Line Pressurizing Pump

Both bilge, fire and GS pumps are permanently set up for the fire main service, with the discharge and suction valves being left open. In an emergency it is possible for the pumps to be used to pump bilges directly overboard from the bilge main which connects to all of the engine room bilge wells. The No.1 pump also has a direct bilge suction from the port forward engine room bilge well. In normal operations however, the bilge suction valves on each pump would be closed. Sea suction for the pumps is from the main sea water crossover line that connects to the high and low sea chests.

It is extremely important that at no time should the bilge suction valves be left open when the pump discharge valves are open onto the fire main. This is due to the risk of oil contamination of the water and the possibility that the pump may lose suction from the bilge well.

The fire line pressurizing pump is normally set to maintain pressure in the fire line. The pump is set to automatic operation and will start and stop as necessary to maintain the fire line pressure. In the event of more than one fire line hydrant being opened, one of the bilge, fire and GS pumps will have to be started to supply sufficient water to the fire main lto maintain pressure.

The bilge, fire and GS pump also has the facility to supply sea water to the fresh water generator ejector. This facility has been fitted to provide back-up to those systems in the event of pump failure or down time due to maintenance.

The pumps are connected through valves WS050F, WS049F and WS048F respectively but during normal operations these valves are to be kept locked closed.

It may be necessary when the ship is trading in cold climates with low sea and air temperatures that the fire main on deck will be isolated from the engine room supply and drained down. Therefore consideration must be given to the condition of the fire main on deck, either isolated or not before the pumps are started for fire fighting or deck wash duties.

Procedure to Set Up the Bilge, Fire and General Service Pumps for Fire Main Duties

It is assumed that the sea water crossover line is in operation on the low sea suction and that each fire hydrant valve in the engine room , accommodation and on deck is closed. It is also assumed that the fire main on deck is not drained down and the isolating valve FD554F in the foam room is open for the supply to deck and the accommodation areas.

Set up the valves as shown in the following table:

Position	Description	Valve
Closed	No.1 bilge, fire GS pump bilge suction	BG012F
Closed	No.1 bilge, fire GS pump direct bilge suction	BG014F
Open	No.1 bilge, fire GS pump sea suction	FD001F
Closed	No.1 bilge, fire GS pump discharge to overboard discharge line	BG015F
Open	No.1 bilge, fire GS pump discharge to fire main	FD003F
Closed	No.2 bilge, fire GS pump bilge suction	BG013F
Open	No.2 bilge, fire GS pump sea suction	FD002F
Closed	No.2 bilge, fire GS pump discharge to overboard discharge line	BG016F
Open	No.2 bilge, fire GS pump discharge to fire main	FD004F
Open	Overboard discharge valve	BG017F

Note: The bilge suction valve on the bilge, fire and GS pumps are interlocked with the fire main discharge valve so that the bilge suction valves may not be opened when the fire main discharge valve is open.

The bilge, fire and GS pumps can be started from the following locations.

- Locally (started and stopped
- The engine control console in the ECR
- The foam room and fire control station
- The main switchboard room (started and stopped)

In order for the bilge, fire and GS to be started automatically, the fire line pressurizing pump must be switched to REMOTE at the group starter on the main switchboard. This pump will now maintain the fire line pressure between 9 and 7kg/cm2. If the fire line pressure drops to 6.5kg/cm2 due to a high demand on the fire line, then one or both bilge , fire and GS pumps will start according to which isolation breaker is in.

The bilge, fire and GS pumps can be started manually at any time as long as the main isolation breaker is in the ON postion.

Procedure to Set Up a Bilge, Fire and General Service Pump for Bilge Pumping Duties

It is assumed that the No.1 bilge, fire GS pump is to be set for bilge pumping duties via the bilge suction main and that No.2 pump has been left line up on the fire main.

Set up the valves as shown in the following table:

Position	Description	Valve
Open	No.1 bilge, fire GS pump bilge suction	BG012F
Closed	No.1 bilge, fire GS pump direct bilge suction	BG014F

Closed	No.1 bilge, fire GS pump sea suction	FD001F
Open	No.1 bilge, fire GS pump discharge to overboard discharge line	BG015F
Closed	No.1 bilge, fire GS pump discharge to fire main	FD003F
Closed	No.2 bilge, fire GS pump bilge suction	BG013F
Open	No.2 bilge, fire GS pump sea suction	FD002F
Closed	No.2 bilge, fire GS pump discharge to overboard discharge line	BG016F
Open	No.2 bilge, fire GS pump discharge to fire main	FD004F
Open	Overboard discharge valve	BG017F

Operation of a bilge, fire and GS pump for pumping out the engine room bilges should only be considered in the event of serious flooding of the engine room spaces and not for general bilge pumping duties. Opening of the direct bilge suction valve from the port forward bilge well allows for ready pumping of engine room flood water. It is essential that all bilge well strainers are maintained in a clear condition at all times.

Flooding of the engine room spaces and the pumps that can be utilized.

Procedure to Set Up the Fire Line Pressurizing Pump

The fire line pressurizing pump must be always set for operation on the fire main. The pump takes suction from the main sea water suction crossover line which must be operational with the high or low sea chest suction valves open.

The fire line pressuring pump suction valve FD017F and discharge valve FD018F must be open and the pump set for REMOTE operation at the main switchboard group starter panel. Additionally, the fire line accumulator should also be in line with its feed valve FD019F open and the pressure vessel filled half way with water and an air damper filling the remaining space.

The pump will maintain the fire main at a constant pressure of 9.0kg/cm2 but is of limited capacity. The pump will provide an immediate fire fighting capability but should more than one hydrant be opened, a bilge, fire and GS pump must be started.

Warning Note:The fire line pressurizing pump can start automatically at any time by an on board fire hydrant valve being opened. The pump must therefore be switched off before undertaking any maintenance work.

2.4.3 EVAPORATOR

Introduction

The Fresh water Generator (F.W. Gen.) installed in the M/T Tradewind Force is a JWP-26-C100 from Alfa Laval. This F.W. Gen. is intended to supply a 30 m3/day of fresh water, but during late April and late May, it produced 2m3 a day. During early June with a new C/E on-board the production of fresh water raised to 10m3 a day.

The ejector in the fresh water generator receives SW from the Ejector pump and also from the Fire and G.S pump, when the Ejector pump is not in operative condition. The fact that receives SW from the Fire and G.S. pump is a modification that are not included in the final piping drawing of the engine room. The Fire and G.S. pump connects with the F.W. Gen Ejector by-passing the Ejector Pump. The inconvenience is that when operating the F.W. Gen with the Fire and G.S. pump it must be installed a blind flange after the Ejector Pump to avoid back flowing due a missing valve right after the pump.

The Alfa Laval plate type evaporator installed in the engine room utilizes the heat available from the main engine jacket cooling water system. The evaporator may also be operated using steam from the 7.5kg/cm2 service steam system, the steam being introduced into a water flow by means of a steam injector.

There are effectively two heating systems for the evaporator and they operate independently of each other. Operation using the main engine HT cooling water is normally employed but operation of the evaporator using steam may be adopted should there be insufficient heat available from the main engine HT cooling fresh water.

The cooling water high temperature water flows from the main engine and into the evaporator through valve WF310F. The water then exists the evaporator and returns to the cooling water circuit through valve WF311F. Not all of the main engine's cooling water passes through the evaporator as valve WF312F ensures that some of the water is bypassed. This valve should never be fully closed during normal operating conditions.

For operation using steam the supply and return valves from the HT cooling system (WE310F and WF311F) are closed and the local closed steam/water system established. The FW priming valve WG035F is opened in order to fill the closed circuit and the return circuit line valve is opened (this valve is normally shut). Steam is injected into this closed circuit by means of the injector and condensation of the steam heats the water which circulates through the evaporator due to the action of the steam injector. Condensation of the steam increases the mass of water in the closed system and the pressure is released by means of relief valve. When the system return circuit line valve is closed and the closed circulation system is drained.

To achieve low temperature evaporation and so improve the efficiency of the unit, the pressure within the evaporator chamber is reduced. This is achieved by the water educator that operates as a brine educator on the evaporator casing.

The feed water is introduced into the evaporator section of the evaporator through an orifice and is distributed into the plate heater where it absorbs energy from the hot water and steam. Having reached boiling temperature which is lower than at atmospheric pressure, the feed water undergoes a partial evaporation and the mixture of generated vapor and brine enters the evaporator chamber. Here the brine is separated from the vapor and extracted by the combined brine and air ejector that is driven by the dedicated ejector pump.

After passing through a demister that hot water vapor enters the condenser plate type heat exchanger fitted near the top of the evaporator.

The sea water supplied by the combined cooling/ejector water pump then cools the vapor down to form distillate. This distillate is extracted by the distillate pump and discharged through a salinometer which monitors the salinity of the water. In the event of the salinity rising above a preset valve and alarm is sounded and the condensate is recycled back to the evaporator chamber.

A flow meter is fitted at the distillate pump discharge to monitor the amount of fresh water being produced. At full capacity the unit is design of producing up to 32 tons of fresh water per day.

Distillate from the FW evaporator is discharged to the two distilled water storage tanks or though a sterilizer and rehardening filter to the two fresh water storage tanks.

Fresh Water Quality

To continuously check the quality of the produced fresh water, a salinometer is provided together with an electrode unit fitted on the distillate pump delivery side. If the salinity of the produced fresh water exceeds the chosen maximum value, the dump valve and alarm are activated and the water is returned to the evaporator chamber.

Main components

The fresh water generator consists of the following components:

Heater Section

The heater or evaporator consists of a plate type heat exchange that is fitted to the outside casing of the unit near the base. It has provision for the fitting of temperature probes at its inlet and outlet.

Evaporator Vessel

The evaporator or separator chamber is cylindrical in shape and is where the hot water vapor and concentrated brine are separated.

Condenser Section

As with the heater section, the condenser consists of a plate type heat exchanger fitted to the outside of the unit. The condenser is mounted above the heater close to the top of the unit and is where the hot vapor is condensed into water.

Combined Brine/Air Ejector

The ejector extracts brine and incondensable gases from the separator vessel.

Fresh Water Ejector Pump

The fresh water ejector pump is a single-stage centrifugal pump that supplies the condenser with sea water and the brine/air ejector with jet water, as well as feed water for evaporation.

Distillate Pump

The distillate pump is a single-stage centrifugal pump that extracts the produced fresh water from the condenser and pumps it to the distilled and fresh water tanks.

Salinometer

The salinometer constinously checks the quality and salinity of the produced water. The alarm set point is adjustable.

Control Panel

A control panel contains motor starters, running lights and contacts for remote alarm. A salinometer control panel is located at the evaporator side with LCD indicators ranging from 0.5-20 ppm. The panel also contains a 5ppm test function and control buttons to set the alarm point.

Chemical Injection Unit

The unit is fitted with a chemical injection unit which connects into the sea water feed inlet side of the evaporator's heater. The unit is operated by a magnetic pump and is intended to inhibit foaming and control the formation of scale on the heating surfaces thereby allowing prolonged operation without the need for a plant shutdown for cleaning. The chemical treatment quantities must be strictly controlled.

Evaporator Operating Procedures

It must be noted to do not operate the plant in restricted waters if the water produced is to be used for human consumption. There are strict regulation governing the operation of fresh water generators near coasts and statuaries and these should be observed. The best information regarding restrictions of operation the fresh water generator when the ship is in coastal waters could be provided by the deck department.

Starting and Stopping Procedures

The arrangement described in for the evaporator working from the HT jacket cooling water circuit.

a- Ensure that power is available and that the alarm and control panels are switched on.
b- Set the valves as follows. It has been assumed that the engine room sea water crossover main is already open and that the system is discharging into the No.1 distilled water tank.

Position	**Description**	**Valve**
Open	Evaporator ejector pump sea water inlet valve	WS036F
Open	Evaporator ejector pump sea water outlet valve	WS037F
Closed	Crossover valve from bilge fire and GS pump	WS049F
Open	Evaporator sea water outlet valve	WS038F
Open	Overboard discharge valve	WS025F
Open	Open Evaporator jacket water inlet valve	WF310F
Open	Evaporator jacket water outlet valve	WF311F
Throttled	Evaporator jacket cooling water bypass valve	WF312F
Closed	Steam injection inlet valve	ST286F
Closed	Steam heated system return circuit line valve	
Closed	Steam heated system fresh water priming valve	WG035F
Open	Steam heated system drain valve	
Closed	Fresh water priming valve	WG035F
Open	Distillate flow meter inlet and outlet valves	
Open	Evaporator distillate outlet valve	WP001F
Closed	Hyper silver ion dosing valve	WG030F
Open	No.1 distilled water storage tank inlet valve	WP018F
Closed	No.2 distilled water storage tank inlet valve	WP019F
Closed	Fresh water valve to rehardening filter	WP002F

c- Close the iar vent valves on the evaporator and set the inlet and outlet valves to allow water to flow through the condenser.
d- Ensure the feed water inlet valve allowing water into the heater is open.
e- Start the ejector pump and create a vacuum of at leas 90% in the evaporator casing. This should be developed in less than 10 minutes.
f- Ensure the chemical injection tank is topped up with fresh water with the correct dosage of chemicals. Open the feed water treatment valve and start the dosing pump.
g- Adjust the evaporator jacket water inlet valve WF310F and the bypass valve WF312F until the desired temperature is reached. The boiling temperature will rise and the vacuum will fall to approximately 80% indicating that evaporation has commenced. After about 3 minutes the temperature will fall and normal vacuum will be restored.
h- Switch on the salinometer and check for operation.

i- Start the fresh water/distillate pump.

The evaporator will operate automatically and discharge distillate to the fresh water tank provided that the quality is above the base level set on the salinometer. Should the quality fall the salinometer will activate an alarm and direct the distillate to the brine chamber of the evaporator for re-evaporation. When the quality returns to an acceptable level the salinometer will close the recirculation valve and output will flow to the distilled water storage tank.

Output of the evaporator can be adjusted by regulating the flow of jacket water to the evaporator by means of the evaporator jacket water bypass valve and the jacket water inlet valve.

Stopping the Plant

a- Stop the hot water supply to the unit by closing the evaporator jacket cooling water inlet and outlet valves and fully opening the bypass valve.
b- Close the feed water treatment valve (if open).
c- Stop the distillate water pump.
d- Switch off the salinometer.
e- Stop the ejector pump.
f- Open the air vent on the separator
g- Close the suction and discharge valve on the ejector pump.
h- Close the inlet valve to the distilled water tank

The Fresh Water Generator Steam Injection System

If there is insufficient heat in the jacket water to allow for operation of the evaporator the steam heating system may be operated. This system is a closed water/steam system where steam is injected into a closed water circuit and condensation of the steam heats the water which circulates through the heat transfer unit of the evaporator.

Procedure for Operating the Steam Injection System

a- Set the system valve as described previously
b- Fully open the HT fresh water system evaporator bypass valve WF312F and close the evaporator HT fresh water inlet and outlet valves WF311F and WF310F.
c- Open the steam heating circuit circulation valve then open the steam heating circuit fresh water priming valve WG035F and close the steam heating circuit drain valve. Close the priming valve when the circuit is filled with water.
d- Open the steam supply valve to the injector ST286F. There are no drain valve to open as the steam condenses in the heating circuit.
e- Operate the evaporator as for normal heating with the heat supplied by the main engine HT fresh water cooling system.

f- The rate of evaporation will depend upon the steam supply to the system. The pressure relief valve in the steam/water heating circuit will release excess pressure caused by the condensation of the steam.

To stop the evaporator the procedure is as above expect that the steam supply valve is closed. The steam heating circuit circulation valve is closed and the circuit drain valve is opened to drain water from the circuit if the evaporator is to be subsequently operated using HT fresh water as a heat source. If the evaporator is to be operated subsequently using steam heating the circuit may remain primed. IF the heating is to come from the HT fresh water system the inlet and outlet vales WF311F and WF310F must be opened and the evaporator bypass valve WF312F must be throttled.

2.4.4 MARINE GROWTH PREVENTION SYSTEM

Marine Growth Prevention System Equipment

- Maker: Korea Cathelco
- Model: 2311
- Flow rate: 5m3/h

Introduction

The growth of marine micro-organisms in the ship's sea water piping is prevented by the injection of chlorine at a controlled rate. The chlorine is injected into the sea suction chests and is circulated throughout the sea water system by the operating pumps.

Chlorine is manufactured in the Marine Growth Prevention System (MGPS) by the electrolysis of the salt (sodium chlorine) in the sea water. A number of different chlorine compounds are formed during the electrolysis but they all have the effect of preventing the growth of marine micro-organisms. A supply of sea water to the MGPS unit is provided through a flow meter off the the main cooling salt water pump line. Illustration 2.4.4a shows the arrangement and how it is connected into the sea water cooling system.

Sea water is supplied to the treatment tank at a controlled rate. The electrolysis cell consists of two copper anodes, two aluminium anodes and one stainless steel cathode. An electric current is applied to the electrodes from the control unit. The input to the KCAF3040 controller is from the ship's 220V single phase system.

The sea water flow rate to the treatment tank is monitored by a flow meter which is connected to the control unit; should the flow fail an alarm is activated. During operation it is important to vent the top of the treatment tank regularly to prevent the build up of air pockets inside. It is also a requirement to drain the tank once per month to remove sediment and the build up of any hydroxide compounds. Care must be taken not to undertaake any burning or welding to the outside of the treatment tank as it has a 3mm internal rubber lining that may be damaged. From the MGPS the sea water containing the chlorine is distributed to the two sea suction chests and hence to the ship's sea water system.

Procedure for Operating the Marine Growth Protection

System

a) Ensure that one of the sea water sea suction chests is open and that one of the main sea water circulating pumps is operating.

b) Adjust the flow meter on the inlet side of the MGPS electrolysis cell to a value above the minimum for the unit.

c) Open the vent on the top of the tank until all entrapped air has been removed.

d) Ensure power is available to the MGPS control panel.

e) Switch on the mains power to the unit using the switch in the bottom left hand corner of the panel. A green neon light will illuminate.

f) Set the anode currents to the levels specified in the operator's manual by turning the control knobs. A read out will be shown in the digital ammeter display Water from the MGPS is pumped to the operating sea chest. There should be a flow to the sea chest which is not operating to prevent marine growth within the sea chest. The water flow to each sea chest may be adjusted by means of the flow valves WS028F and WS029F.

The MGPS unit is designed for automatic control for two different water flow conditions, one when the vessel is in a normal sea going condition and one when the vessel is discharging cargo.

2.5 Fresh Water Cooling Systems

2.5.1 Main Engine Jacket Cooling Fresh Water System

2.5.2 Central Fresh Water Cooling Systems

2.5 FRESH WATER COOLING SYSTEMS

2.5.1 MAIN ENGINE JACKET COOLING FRESH WATER SYSTEM

Main Engine Jacket Cooling Fresh Water Pump

- Maker: Teikoku Machinery Works Ltd
- No. of sets: 2
- Model: 150TVS-A1m
- Capacity: 140m3/h at 3.0kg/m2
- Motor: 22kW at 1,800 rpm

Introduction

The system has two fresh water cooling pumps rated at 140m3/h with a discharge pressure of 3.0kg/cm2. The pumps supply cooling water to the main engine jackets, cylinder heads and exhaust valves and circulate hot water through the fresh water (FW) generator. The main engine jacket cooling water system is classed as the High Temperature (HT) cooling fresh water system and operates on a closed circuit principle. The pumps discharge through the jacket cooling water preheater. The preheater maintains the main engine jacket cooling water temperature when the main engine is at idle or operating on low load. It is also used when the engine is being warmed through after prolonged period at rest prior to starting.

The FW evaporator can be bypassed when the main engine is on low load, or when the production of fresh water is not required. A separate steam heater system allows fresh water to be made when the main engine is not available.

The FW evaporator extracts heat from the HT cooling water so reducing the load on the cooler. After passing through the FW evaporator, the jacket water returns to the jacket cooling water pump suction via a deaerating tank. A three-way temperature control valve actuated by the automatic temperature controller with a set point of 82ºC at the engine outlet, directs the flow of water back to the pump suction or to the main engine jacket water cooler. The jacket cooler is cooled by water circulating in the low temperature central fresh water cooling system. Operation of the evaporator provides for cooling of the HT water.

A cooling fresh water expansion tank provides a positive head on the engine to maintain pressure and to allow for thermal expansion of the water. This tank is supplied with water from the fresh water hydrophore system via manual valve WG033F. The deaeration tank, located before the jacket cooling water pump suction, vents to the cooling fresh water expansion tank via an air detector alarm.

Branches from the engine cooling water manifold supply cooling water to each of the main engine cylinders. Isolating valves are fitted to the inlet and outlet for each cylinder to allow units to be individually isolated for maintenance purposes.

The HT cooling system can be drained to a maintenance tank. An air operated jacket water transfer pump is provided to transfer the water in the tank bck into the main engine or to the bilge.

A chemical dosing unit is provided for adding corrosion inhibitor chemicals to the jacket cooling water system. The dosing unit pump connects to the jacket water pump suction manifold.

Preparation for the Operation of the Jacket Cooling Water System

a- Ensure that the cooling fresh water expansion tank is charged to the correct level and that the main engine jacket cooling water system is vented and charged.
b- Ensure that all pressure gauge and instrumentation valves are open and that the instruments are reading correctly.
c- Ensure the FW evaporator is bypassed by opening valve WF312F.
d- Ensure that all main engine individual cylinder inlet and outlet valves are open and that the drain valve WF324F to the maintenance tank is closed. The topping up line valve WF325F from the maintenance tank pump should also be closed.
e- Ensure that all main engine individual cylinder vent and drain valves are closed.
f- Set the valves as shown in the table below.

Note: The fresh water generator hot water valve settings are described in section 2.4.4 (Evaporator) and will be set accordingly when the fresh water generator is operating.

Position	**Description**	**Valve**
Open	No.1 jacket cooling water pump suction valve	WF302F
Open	No.1 jacket cooling water pump discharge valve	WF304F
Open	No.2 jacket cooling water pump suction valve	WF303F
Open	No.2 jacket cooling water pump discharge valve	WF305F
Open	Preheater inlet valve	WF306F
Open	Preheater outlet valve	WF307F
Throttled	Preheater bypass valve	WF308F
Open	Main engine outlet valve	WF309F
Open	Main engine outlet manifold vent valve	WF317F
Open	Cooling fresh water expansion tank outlet valve	WF301F
Open	Fuel oil tracing by jacket water return valve	WF316F
Operational	Main engine jacket temperature control three-way valve	WF315F
Open	Jacket cooler fresh water inlet valve	WF313F
Open	Jacket cooler fresh water outlet valve	WF314F
Open	Fresh water generator bypass valve	WF312F

Jacket Cooling Water System Operation

a- Start one main engine jacket cooling fresh water pump.
b- Check that the system automatic vent valve is operating correctly.

c- Open the condensate outlet valve from the steam preheater SD013F and then open the steam inlet valve ST235F.

d- Slowly bring the jacket temperature up to operating temperature. Observe the engine builder's instructions regarding the rate of temperature rise. Check the system for leaks as the temperature rises.

e- Ensure that sea water is being supplied to the low temperature central coolers and that the low temperature central cooling system is operating.

f- Test the system for chemical concentration and add chemicals as required using the chemical dosing unit. The high temperature system is independent of the low temperature system and so has a dedicated chemical treatment unit.

g- Switch the other jacket cooling water pump to standby duty for automatic cut-in.

h- When the engine is operating and at full power, check the automatic operation of the cooling system and, when satisfied, the steam supply to the jacket water preheater can be isolated and the evaporator brought into operation if required.

The temperature drop in the jacket cooling water across the fresh water generator depends upon the amount by which the evaporator bypass valve is open. The evaporator may be operated utilizing the heat energy from the main engine when the engine is under sufficient load to provide the heat required. If the engine is running on reduced load, the water making capacity can be maintained by using the steam heater fed off the 4.5jg/cm2 engine room system.

2.5.2 CENTRAL FRESH WATER COOLING SYSTEMS

Central Cooling Fresh Water Pump

- Maker: Teikoku Machinery Works Ltd
- No. of sets: 2
- Model: 300TVD-A1M
- Capacity: 760m3/h at 2.5kg/cm2
- Motor: 75kW at 1,800 rpm Introduction

The low temperature central fresh water cooling system works on the closed circuit principle and has the following features:

- Two main circulating pumps which can each supply cooling water for the services at a rate of 760m3/h at 2.5kg/cm2. Normally one pump will be operating and the other on standby. A pressure switch on the pump discharge line set at 3.0kg/cm2 stats the standby pump on low system pressure.
- Two central coolers which in turn are cooled by sea water are each rate for 100% of the cooling requirement.
- An expansion tank which provides a positive head to the system as well as allowing for thermal expansion of the circulating water. This tank can be topped up from the domestic fresh water system directly via the manual valve WG034F.

The two low temperature cooling fresh water pumps take suction from the system suction main. Connected to this are the return lines from the cooling systems and the cooling fresh water expansion tank. The pumps discharge to an outlet line which supplies water to the various items of engine room equipment. The outlet line from the central coolers is fitted with a three-way temperature controlled valve which regulates the flow of water through the cooler(s) to 36ºC at the pump outlets.

A sub-system of the low temperature cooling system is also used to supply the three generators engines. Fitted to these are lubricating oil coolers, charge air coolers and alternator air coolers. To ensure adequate pressures and flows are maintained through the engines, each is fitted with its own engine driven booster pump. The generator cooling water system also incorporates three electric water preheating units, one for each engine, which are used when the vessel has been drydocked or before operating an engine which has been shut down for maintenance. It is important to maintain a standby generator at its correct operating temperature to allow for immediate starting.

The generators' cooling system are permanently vented from the highest point on the engine to the cooling water expansion tank through valves VA0521F, VA052F and VA053F for engines No.1 to No.3 respectively.

Central Fresh Water Cooling System

The central fresh water low temperature cooling system pumps are used to supply the following engine room equipment and services:

- Main engine jacket fresh water cooler
- Main engine charge air cooler
- Main engine LO cooler
- Generator engine jacket water coolers
- Generator engine charge air coolers
- Generator alternator air coolers
- Main switchboard air conditioning unit
- Workshop air conditioning unit
- Main starting air compressors
- Accommodation air conditioning plants
- Provision room refrigeration plants
- Air ejector condenser
- Atmospheric condenser
- Stern tube LO cooler

Preparation for the Operation of the Low Temperature Cooling Water System

a- Replenish the system from the expansion tank, which is filled from the fresh water system via valve WG034F.

b- Ensure that all pressure gauge and instrumentation valves are open and that instruments are reading correctly.

c- Set up valves as shown in the tables that follow. It has been assumed that the No.1 central cooler is in operation and that No.2 is isolated.

Position	Description	Valve
Open	No.1 central cooling water pump suction valve	WF006F
Open	No.1 central cooling water pump discharge valve	WF010F
Open	No.1 central cooling water pump suction valve	WF007F
Open	No.1 central cooling water pump discharge valve	WF011F
Closed	Chemical treatment unit supply valve	WF050F
Closed	Preheater outlet valve	WF049F
Operational	Central cooler three-way bypass valve	WF308F
Open	No.1 central cooler inlet valve	WF001F
Open	No.1 central cooler outlet valve	WF003F
Closed	No.2 central cooler inlet valve	WF002F
Closed	No.2 central cooler outlet valve	WF004F
Open	Outlet valve from expansion tank	WF052F
Closed	Drydock operation valves	

System Valves

Position	Description	Valve
Open	Main engine LO cooler inlet valve	WF012F
Open	Main engine LO cooler outlet valve	WF013F
Open	Main engine jacket FW cooler inlet valve	WF014F
Open	Main engine jacket FW cooler outlet valve	WF015F
Open	Main engine air cooler inlet valve	
Open	Main engine air cooler outlet valve	
Open	Main engine air line outlet valve	WF016F
Open	Stern tube LO cooler inlet valve	WF043F
Open	Stern tube LO cooler outlet valve	WF044F
Open	Deck machinery power pack cooling inlet valve	
Open	Deck machinery power pack cooling outlet valve	
Open	No.1 main air compressor inlet valve	WF045F
Open	No.1 main air compressor outlet valve	WF047F
Open	No.2 main air compressor inlet valve	WF046F
Open	No.2 main air compressor outlet valve	WF048F
Open	No.1 boiler water circulating pump inlet valve	WF053F
Open	No.1 boiler water circulating pump outlet valve	WF054F
Open	No.2 boiler water circulating pump inlet valve	WF055F
Open	No.2 boiler water circulating pump outlet valve	WF056F

Generator Engine System

Position	Description	Valve
Operational	Temperature controlled three-way valve	WF351F
Open(locked)	Link valve between HT and LT systems	WF364F

No.1 Generator Engine

Position	Description	Valve
Open	Alternator cooling inlet valve	WF365F
Open	Alternator cooling outlet valve	WF368F
Open	Air and LO cooler inlet valve	WF358F
Open	Air and LO cooler outlet valve	WF361F
Open	Jacket system inlet valve	WF352F
Open	Jacket system outlet valve	WF355F
Open	High temperature system vent valve	VA051F

No.2Generator Engine

Position	Description	Valve
Open	Alternator cooling inlet valve	WF366F
Open	Alternator cooling outlet valve	WF369F
Open	Air and LO cooler inlet valve	WF359F
Open	Air and LO cooler outlet valve	WF362F

Open	Jacket system inlet valve	WF353F
Open	Jacket system outlet valve	WF356F
Open	High temperature system vent valve	VA052F

No.3 Generator Engine

Position	Description	Valve
Open	Alternator cooling inlet valve	WF367F
Open	Alternator cooling outlet valve	WF370F
Open	Air and LO cooler inlet valve	WF360F
Open	Air and LO cooler outlet valve	WF363F
Open	Jacket system inlet valve	WF354F
Open	Jacket system outlet valve	WF357F
Open	High temperature system vent valve	VA053F

Refrigeration and Air Conditioning Units

Position	Description	Valve
Open	Branch system supply valve	WF027F
Open	No.1 air conditioning plant inlet valve	
Open	No.1 air conditioning plant outlet valve	
Open	No.2 air conditioning plant inlet valve	
Open	No.2 air conditioning plant outlet valve	
Open	System vent valve to expansion tank	
Closed	No.1 air conditioning plant bypass valve(locked)	WF028F
Open	No.1 refrigeration plant inlet valve	
Open	No.1 refrigeration plant outlet valve	
Open	No.2 refrigeration plant inlet valve	
Open	No.2 refrigeration plant outlet valve	
Open	System vent valve to expansion tank	
Open	Sample cooler inlet valve	WF037F
Open	Sample cooler outlet valve	WF038F
Closed	Sampling connection valve	WF039F
Open	No.1 main switchboard unit cooler inlet valve	WF031F
Open	No.1 main switchboard unit cooler outlet valve	WF032F
Open	Atmospheric condenser inlet valve	WF040F
Open	Atmospheric condenser outlet valve	WF041F
Closed	Atmospheric condenser bypass valve	WF042F

d- Start one central cooling water pump

e- Operate the generator engine preheater as required

f- Slowly bring the generator engine jacket temperature up to operating temperature. Observe the engine builder's instructions regarding the rate of temperature rise. Check the system for leaks as the temperature rises.

g- Supply sea water to the duty central FW cooler.

h- Check the expansion tank level and replenish if necessary.

i- Test the system for chemical concentration and add chemicals as required using the chemical treatment tank.

j- Circulate the LT central fresh water cooling system and check that all users are bein supplied with CFW at the required temperature. Services mya be supplied and isolated as necessary.

k- Set the standby pump to automatic cut-in.

2.6 Fuel Oil and Diesel Oil Service Systems

2.6.1 Main Engine Fuel Oil Service System

2.6.2 Generator Engine Fuel Oil Service System

2.6.3 Auxiliary Boiler Fuel Oil System

2.6.4 Incinerator Fuel Oil System

2.6.5 Emergency Generator Fuel Oil System

2.6 FUEL OIL AND DIESEL OIL SERVICE SYSTEMS

2.6.1 MAIN ENGINE FUEL OIL SERVICE SYSTEM

Fuel Oil Supply Pumps

- Maker: IMO
- Model: ACE 038K3
- No. of sets: 2
- Capacity: 5.0m3/h at 4.0kg/cm2

Fuel Oil Circulating Pumps

- Maker: IMO
- Model: ACE45K6
- No. of sets: 2
- Capacity: 10m3/h at 6.0kg/cm2

Introduction

Heavy fuel oil (HFO) is stored on board the vessel in four HFO storage tanks. The fuel oil is transferred to settling tanks by the HFO transfer pumps where any water or sediment can be drained by the use of self-closing test cocks. From the HFO settling tanks the fuel can be supplied directly to the boiler fuel oil system but before use in the main and generator engines, the fuel must be centrifuged in one of two purifiers. Having been processed in this way, the fuel is directed to the HFO service tank. Fuel oil from this tank is then supplied to the main engine and generator engines through a common fuel supply system.

The HFO service tank can also be lined up to supply the boilers. The main engine and three generator engines are designed to run on HFO at all times but have the facility to switch to marine diesel oil if the need should arise. One of the HFO purifiers will be running at all times, with the throughput balanced to match the fuel consumption of the main engine and generator diesel engine. For burning HFO in the boilers, main engine or generator engines, the fuel will need to be heated to the correct viscosity for pumping and fuel injection. The viscorator achieves this by regulating the temperature of the fuel in the fuel oil heaters by controlling the 7.5kg/cm2 steam supply to those heaters. All of the fuel pipes are also trace heated to maintain fuel temperature.

Outlet valves from the service and settling tanks are remote quick-closing with a collapsible bridge which can be pneumatically operated from the fire control station. After being tripped the valves must be reset locally. Each tank is also fitted with a self-closing test cock to test for and drain any water present. Tundishes under the self-closing test cocks drain any test liquid to the bilge primary tank. All tanks and heaters are supplied with saturated steam at

7.5kg/cm2 from the ship's steam supply, with the condensate returning to the cascade/feed filter tank, which is fitted with an oil detection unit.

Heated and filtered HFO is supplied to the main engine from the HFO service tank. The fuel is supplied to the main engine by one of two HFO supply pumps. The second pump will be on automatic standby and will start in the event of a discharge pressure drop to 2.5kg/cm2 or a voltage failure of the running pump.

The HFO supply pumps discharge through a HFO flow meter to the suction side of the FO circulating pumps. A pressure control valve with its sensing point on the supply pump discharge, maintains the supply pump's discharge pressure at 4.0kg/cm2 by recirculating oil from the pump discharge back to the pump suction.

The return HFO from the main engine and generator engines flows back to the HFO return pipe. This pipe is lagged and steam heated. It is fitted with an automatic vent valve which vents to the FO overflow drain tank.

HFO is drawn from the return pipe and the supply pump discharge by one of two main engine HFO circulating pumps. The second pump will be on automatic standby and will start in the event of a discharge pressure drop to 5.0kg/cm2 or a voltage failure of the running pump. The HFO circulating pumps discharge through one of a pair of main engine FO heaters, where the oil is heated to a temperature corresponding to a viscosity of 12cSt using steam at 7.5kg/cm2.

The heated FO then passes through a viscorator and an automatic backflush filter, which has a 50 micron bypass filter for use during maintenance on the main filter. The filter is an automatic self-cleaning unit, with an electrically operated cleaning mechanism that runs at all times.

Both the main engine and generator engines have pneumatically operated quick-closing valves on the fuel oil supply line immediately before the respective engines, these valves are operated from the control board outside the main switchboard room on the 3rd deck level and adjacent to the CO2 release station.

The heated FO flows to the main engine fuel rail on the suction side of the main engine high pressure FO injection pumps.

Individual fuel injection pumps on the main engine take suction from the engine fuel rail with any excess fuel being returned to the FO return pipe. A return line on the mixing unit connects with the overflow line to the HFO service tank and this arrangement allows the fuel system to be flushed back to the HFO service tank. This facility is used when changing the engine over to diesel when it is expected that the engine will be stopped for a prolonged period of time.

The high pressure FO lines on the main engine are sheathed, any leakage into the annular spaces formed by the sheathing is led to a FO leakage tank. The tank is fitted with a high level alarm which gives advance warning of a leaking fuel injection pipe. The leakage tank overflows to the FO overflow tank.

FO is supplied to the generator engine fuel systems via a flow meter and the return fuel from the generator engine system also passes through a flow meter, allowing the generator engine fuel consumption to be determined. The main engine fuel consumption is the total fuel consumption, as read from the supply pump flow meter, minus the generator engine consumption. A quick-closing valve is fitted at each generator engine fuel inlet.

Preparation for the Operation of the Main Engine Fuel Oil Service System

a) Put the HFO purifier in use, filling the service tank from the settling tanks.

b) Ensure the filters are clean.

c) Ensure that all the instrumentation valves are open.

The following procedure illustrates starting the main engine from cold with the system charged with diesel oil from a shut down condition. It has been assumed that No.1 HFO heater will be used and No.2 isolated.

Set up the valves as in the following table

Position	Description	Valve
Open	HFO service tank suction quick-closing valve	OF201F
Closed	HFO line suction valve	OF202F
Open	MDO service tank suction quick-closing valve	OD101F
Open	MDO line suction valve	OD102F
Set	Three-way HFO/MDO	OF208F
Open	No.1 FO supply pump suction valve	
Open	No.1 FO supply pump discharge valve	
Open	No.2 FO supply pump suction valve	
Open	No.2 FO supply pump discharge valve	
Open	Pressure control valve inlet valve	
Operational	Pressure control valve	
Open	Pressure control valve outlet valve	
Closed	Pressure control valve bypass valve	
Open	Flow meter inlet valve	
Open	Flow meter outlet valve	
Closed	Flow meter bypass valve	
Open	No.1 FO circulating pump suction valve	
Open	No.1 FO circulating pump discharge valve	
Open	No.2 FO circulating pump suction valve	
Open	No.2 FO circulating pump discharge valve	
Open	No.1 FO heater inlet valve	
Open	No.1 FO heater outlet valve	
Closed	No.2 FO heater inlet valve	
Closed	No.2 FO heater outlet valve	
Closed	Heater bypass valve	
Open	Backflush filter inlet three-way cock	
Open	Backflush filter outlet three-way cock	

Closed	Bypass filter inlet three-way cock	
Closed	Bypass filter outlet three-way cock	
Open	Viscosity controller inlet valve	
Open	Viscosity controller outlet valve	
Closed	Viscosity controller bypass valve	
Operational	Fuel line pressure control valve(set at 9.0kg/cm2)	
Open	Main engine fuel manifold inlet valve	OF203F
Open	Main engine fuel manifold quick-closing valve	OF134F
Set	Back pressure relief valve(set at 8.0kg/cm2)	
Open	Main engine fuel oil return valve	OF204F
Open	Return pipe inlet valve	OF205F
Closed	FO return valve to HFO service tank	OF206F
Open	FO return pipe vent valve inlet valve	

The engine would operate on MDO with no steam being supplied to the heaters.

System and Change Over to Heavy Fuel Oil

The system is shut down with DO in the pipelines, a condition similar to starting up after refit. System valves are set as above.

a- Supply steam heating to the HFO service tank.
b- Open all the individual fuel inlet valves on the main engine fuel inlet main.
c- Open the main HFO suction line valve OF202F. Change the three-way HFO/MDO suction valve OF208F so that suction is taken from the HFO service tank.
d- Supply trace heating to the FO service system pipelines.

Note: Trace heating should not be applied to sections of pipeline isolated by closed valves on the FO side as damage could occur due to the expansion of the contents.

e- Manually start supplying steam to the on-line FO heater.
f- Start one FO supply pump and one FO circulating pump.
g- Raise the temperature to about 75°C.
h- Start the viscosity controller.
i- Open the HFO service tank return valve OF206F and close the return pipe inlet valve OF205F.
j- DO will now be expelled to the HFO service tank, at the same time drawing in HFO from the service tank.
k- Continue to raise the temperature manually.
l- When the set point is reached on the viscosity controller, change its setting to AUTOMATIC.
m- Open the return pipe inlet valve OF205F and close the HFO service tank return valve OF206F.

n- Change the operation of the FO heater steam control valve to AUTOMATIC. Open the steam inlet valve fully. HFO is now circulating through the system.
o- Switch the other FO supply pump to standby.
p- Switch the other FO circulating pump to standby.

The system is now ready for operation of the main engine on HFO. The relatively small amount of MDO pumped to the HFO service tank will not change the properties of the HFO in the tank provided that the tank is reasonably full.

Fuel Changeover

The main engine is designed to run on HFO at all times. However, changeover to DO can become necessary if, for instance, the vessel is expected to have a prolonged inactive period with a cold engine due to:

• A major repair of the fuel oil system etc.

• A docking

• More than five day stoppage

• A failure of the HFO heating steam supply

Changeover can be performed at any time, during engine running or during engine standstill. In order to prevent fuel pump and injector sticking/scuffing, poor combustion or fouling of the gas ways, it is very important to carefully follow the changeover procedures.

Changeover Procedure from Diesel Oil to Heavy Fuel Oil

During Running

To protect the injection equipment against rapid temperature changes, which may cause sticking/scuffing of the fuel valves, of the fuel pump plungers and suction valves, the changeover is carried out as follows (manually):

a- First, ensure that the HFO in the service tank is at normal temperature level.
b- Reduce the engine load to 75% of normal. Then, by means of the thermostatic valve in the steam system, or by manual control of the viscosity regulator, the MDO is heated to a maximum 60- 80°C, in order to maintain the lubrication ability of the MDO and in this way minimize the risk of plunger scuffing and the consequent risk of sticking. This preheating should be regulated to give a temperature rise of approximately 2°C per minute.
c- Due to the above mentioned risk of sticking/scuffing of the fuel injection equipment, the temperature of the HFO in the service tank must not be more than 25°C higher than the heated diesel oil in the system (60-80°C) at the time of changeover.

Note: The diesel oil viscosity should not drop below 2cSt, as this might cause fuel pump and fuel valve scuffing, with the risk of sticking.

d- For some light diesel oils (gas oil), this will limit the upper temperature to somewhat below 80°C. When 60-80°C has been reached, the change to HFO is performed by opening the HFO line valve OF202F and the three-way suction valve OF208F is changed over to take suction from the HFO service tank and closing the MDO supply line valve, OD102F. The temperature rise is then continued at a ratio of about 2ºC pre minute, until reaching the required viscosity.

Changeover from Heavy Fuel Oil to Diesel Oil During Running

To protect the FO injection equipment against rapid temperature changes, which may cause scuffing with the risk of sticking of the fuel valves and of the fuel pump plungers and suction valves, the changeover to DO is performed as follows (manually):

a- Ideally the diesel oil in the MDO service tank is at 50°C, if possible.
b- Shut off the steam supply to the FO preheater and steam tracing.
c- Reduce the engine load to 75% of MCR load.
d- Change to MDO when the temperature of the HFO in the preheater has dropped to about 25°C above the temperature in the DO service tank, however, not below 75°C.
e- Open the MDO supply line valve OD102F and change the three-way suction valve OF208F so that suction is taken from the MDO service tank. Close the HFO supply valve OF202F. MDO is now led to the supply pumps.

Note: If, after the changeover, the temperature at the preheater suddenly drops considerably, the transition must be moderated by supplying a little steam to the preheater, which now contains MDO. Overheating must be avoided to prevent the MDO gassing in the pipework.

Changeover from Heavy Fuel Oil to Diesel Oil during Standstill

a- Stop the preheating.
b- Stop the trace heating.

With reference to temperature levels before changeover, see ‘Changeover from Heavy Fuel Oil to Diesel Oil during Running’.

c- Open the MDO supply valve OD102F and change the three-way suction valve OF208F so that suction is taken from the MDO service tank.
d- Close the HFO supply valve OF202F.

e- Open the HFO service tank return valve OF206F and close the FO return pipe inlet valve OF205F so that the HFO is pumped to the HFO service tank. Ensure that there is sufficient ullage in the HFO service tank.

f- Start a HFO supply pump and a HFO circulating pump. When the HFO is replaced by MDO stop the pumps and close the HFO service tank return valve OF206F and open the FO return pipe inlet valve OF205F.

g- Stop the viscosity controller.

h- Stop the FO service and circulating pumps.

2.6.2 GENERATOR ENGINE FUEL OIL SERVICE SYSTEM

Fuel Oil Supply Pumps

- Maker: IMO
- Model: ACE 038K3
- No. of sets: 2
- Capacity: 5.0m3/h at 4.0kg/cm2

Fuel Oil Circulating Pumps

- Maker: IMO
- Model: ACE45K6
- No. of sets: 2
- Capacity: 10m3/h at 6.0kg/cm2

Generator Engine Diesel Oil Pump

- Maker: IMO
- Model: ACE 025N
- No. of sets: 1
- Capacity: 1.5m3/h at 7.0kg/cm2

Generator Engine Emergency Diesel Oil Pump (Air Driven)

- Maker: Crane
- Model: DL25-CA-NNN
- No. of sets: 1
- Capacity: 1.0m3/h at 5.5kg/cm2

Introduction

The three generator engines are designed to run on HFO at all times and the main engine fuel oil supply system is also used for supplying fuel oil to the generator engines.

A fuel oil branch is taken from the main engine fuel supply line just before the inlet valve to the main engine fuel oil manifold and this supplies the generator engines via a flow meter. Each generator engine is supplied with fuel oil from the supply manifold with excess fuel returning to the main fuel return system via a flow meter. There is a quick-closing valve at the fuel inlet to each generator engine, these valves are operated from a control board on the purifier room bulkhead.

The high pressure FO lines on the generators are sheathed, any leakage into the annular spaces formed by the sheathing is led to a FO leakage tank, which is fitted with a high level alarm to give advance warning of a leaking fuel injection pipe.

The above system can be used with either HFO or MDO, but will normally be used for HFO, only changing over to MDO during maintenance and long shut down periods such as refit. As the main and generator engines use the same fuel supply system it follows that the main and generator engines will be changed to MDO if the supply system is changed.

A separate generator engine diesel oil pump is provided and this is used to pressurize the generator engine diesel oil supply line. This enables one or more generator engines to be operated on diesel fuel independent of the main engine and the other generator engines. This arrangement allows a generator engine's fuel system to be flushed through with diesel oil prior to shutting down for maintenance.

An air driven generator engine emergency diesel oil pump is supplied for emergencies. The air supply to the air operated pump is always open allowing the pump to supply MDO to the operating generator engines immediately in the event of a blackout. The pump is started immediately a blackout occurs. A manual air supply valve enables the pump to be operated manually.

Operation of the Generator Engine Fuel Oil Service System On Heavy Fuel Oil

a- Operate the main fuel supply system as described in section 2.6.1 of this report.
b- Ensure that all instrumentation valves are open.
c- With the main fuel supply system operating, set the valves as in the following table for the generator engines to operate on HFO.

Position	Description	Valve
Open	Generator engine supply flow meter inlet valve	OF101F
Open	Generator engine supply flow meter outlet valve	OF103F
Open	Generator engine supply flow meter bypass relief valve	OF118F
Open	Generator engine fuel line flow valve(set at 1.93m3/h)	OF105F
Open	HFO return line pressure regulating valve(set at 6.0kg/cm2)	OF106F
Open	Generator engine return flow meter inlet valve	OF113F
Open	Generator engine return flow meter outlet valve	OF115F
Open	Generator engine return flow meter bypass relief valve	OF117F
Open(locked)	Diesel oil supply non-return valve	OD103F
Open(locked)	Diesel oil supply non-return valve	OD104F

No.1 Generator Engine

Position	Description	Valve
Open	Fuel inlet quick-closing valve	OF131F
Open	HFO inlet valve	OF107F
Open	HFO outlet valve	OF110F
Closed	MDO inlet valve	OF106F
Closed	MDO outlet valve	OD109F
Open	Fuel outlet valve	

No.2 Generator Engine

Position	Description	Valve
Open	Fuel inlet quick-closing valve	OF132F
Open	HFO inlet valve	OF108F
Open	HFO outlet valve	OF111F
Closed	MDO inlet valve	OF107F
Closed	MDO outlet valve	OD110F
Open	Fuel outlet valve	

No.3 Generator Engine

Position	Description	Valve
Open	Fuel inlet quick-closing valve	OF133F
Open	HFO inlet valve	OF109F
Open	HFO outlet valve	OF112F
Closed	MDO inlet valve	OF108F
Closed	MDO outlet valve	OD111F
Open	Fuel outlet valve	

Position	Description	Valve
Open	MDO return line pressure regulating valve(set to 4.0kg/cm2)	OD112F
Open	MDO supply line pressure regulating valve(set to 6.0kg/cm2)	OF105F
Open	MDO service tank quick-closing outlet valve	OF101F
Open	Generator engine DO pump suction valve	
Open	Generator engine DO pump discharge valve to generator engines	
Closed	Generator engine DO pump discharge valve to incinerator DO service tank	
Open	Generator engine emergency DO pump suction valve	
Open	Generator engine emergency DO pump	

	discharge valve	
Open	Generator engine emergency DO pump air supply valve	

Under normal circumstances the system will be primed and operating on HFO. A change to MDO is only made for emergency reasons or if an engine is to be shut down or the fuel system is to undergo maintenance. The fuel system of an engine may be flushed through with MDO prior to stopping or after stopping to facilitate maintenance.

For drydocking or a similar prolonged stay in port the entire generator engine fuel system must be changed to MDO and following entry into service the entire system changed back to HFO. It is simpler to change the entire system to a different fuel type at one time rather than to try and change over individual engines as the fuel system is designed to ensure that even engines which are not running are circulated with fuel. To avoid electrical supply problems when changing over supplies, only one generator engine should be running and the load on that should be reduced to as low as possible. If only one engine is to be changed to diesel oil operation that engine should be running off load to avoid possible electrical supply problems.

Procedure to Change the Generator Engine Fuel Oil System from Operation on Heavy Fuel Oil to Marine Diesel Oil

The procedure to change the fuel supply is the same as for changing the main engine fuel system from HFO to MDO as the generator engines will be operating on HFO from the main system. This procedure has been detailed in section 2.6.1 of this report.
The electrical load on the operating generator engines should be as low as possible when undertaking this changeover. As the entire fuel system is to be changed to MDO, all three generator engines should be running to ensure that the entire fuel system is included. The operating engine(s) may be shut down when required. The fuel system for the generator engines is primed with MDO.

Procedure to Change the Generator Engine Fuel Oil Service System from Operation on Marine Diesel Oil to Heavy Fuel Oil

After drydocking or a similar prolonged stay in port with the generator fuel system on MDO, a change over to HFO operation is required when the ship is to enter service. The procedure is the same as for changing the main engine from MDO to HFO operation as covered in section 2.6.1 of this manual. To avoid electrical supply instability it might be preferable to retain one generator engine operating on MDO whilst the main fuel system along with the other two generator engines, is changed to HFO. The generator engines whose fuel systems have been changed to HFO may then be started and allowed to take the electrical load. The engine operating on MDO may then be unloaded and changed to HFO operation in the same manner.

Procedure for Changing Over Fuel on One Generator Engine Only

It is possible to purge the fuel system of one engine and replace the HFO with MDO to assist in maintenance while the other generator engines remain operating on HFO. This procedure requires operation of the generator engine diesel oil supply pump. The individual engine HFO and MDO outlet valves must be set so that the excess fuel from the engine returns to the correct place, the return pipe for HFO operation or the MDO service tank for MDO operation.
The example given assumes that generator engines No.1 and No.2 are to remain operating on HFO and No.3 generator engine fuel system is to be flushed with MDO. Ideally the engine to be flushed through should either be stopped or operating off load. The description below assumes that the engine is stopped.

a- Set the additional valves as in the following table. Valves for the normal operation of the generator engines on HFO remain unchanged.

Position	Description	Valve
Open	MDO service tank quick-closing outlet valve	OD101F
Open	Generator engine DO pump suction valve	
Open	Generator engine DO pump discharge valve to generator engines	
Closed	Generator engine DO pump discharge valve to incinerator DO service tank	

b- Set the No.3 generator engine fuel inlet and return valves as in the table below.

Position	Description	Valve
Open	Fuel inlet quick-closing valve	OF133F
Closed	HFO inlet valve	OF109F
Open	HFO outlet valve	OF112F
Open	MDO inlet valve	OD108F
Closed	MDO outlet valve	OD111F

No.1 and No.2 generator engines will operate as normal on HFO.

c- Start the generator engine DO pump.

MDO will be pumped by the generator engine DO pump to No.3 generator engine. Because the HFO outlet valve is open the excess HFO in No.3 engine system will be displaced by the MDO and the displaced HFO will flow to the generator engine FO return pipe.

d- When No.3 generator engine fuel system is completely charged with MDO, stop the generator engine MDO pump and close all fuel valves to and from No.3 generator engine.

Note: The procedure for flushing through the engine fuel system with MDO whilst the engine is still running is the same as above except for the following.
The MDO outlet valve from the engine, OD111F in this case, must be opened when the fuel system is charged with MDO and the outlet valve to the HFO system, OF112F in this case, must

be closed. The generator engine MDO pump must remain running whilst a generator engine is operating on MDO.

Emergency Operation Fuel System

In an emergency such as a blackout, no electrical power is available to operate the FO supply and booster pumps, therefore an air operated pump has been provided to supply MDO to the generator engines. This will allow at least one engine to be started and put on the switchboard so restoring ship's power.

The pump inlet and outlet valves are left open at all times together with the MDO service tank quick-closing outlet valve OD101F. The generator engine fuel system supply non-return valves OD103F and OD104F are locked open at all times. The air supply line to the air motor is also always left open.

In the event of a blackout the air driven pump starts automatically and supplies MDO to the generator engine fuel system. One of the generator engines can be started and when electrical power is available the electrically driven pumps may be operated and the air driven pump stopped.

2.6.3 AUXILIARY BOILER FUEL OIL SYSTEM

Auxiliary Boiler Fuel Oil Booster Pump

- Maker: Teikoku Machinery Works Ltd
- Model: MSE-7.5XA
- No. of sets: 2
- Capacity: 5.8m3h at 26kg/cm2

Auxiliary Boiler Diesel Oil Ignition Pump

- Maker: Danfoss
- Model: Gear type RSA
- No. of sets: 2
- Capacity: 0.3m3h at 26kg/cm2

Introduction

Heavy Fuel Oil (HFO) is stored on board in four HFO storage tanks, and then transferred to the settling tanks by a transfer pump. Here any water or other sediment is drained off, using a self-closing test cock. The fuel oil is then purified and discharged to the HFO service tank.

Fuel oil is supplied to the boilers from the HFO service tank. Alternatively, HFO can be supplied directly from the settling tanks.

Marine diesel oil (MDO) can be supplied to the boilers from the MDO settling or service tanks for starting from cold. MDO is also supplied to both boilers for pilot burner operation.

The steam supply to the FO supply heaters is controlled by a temperature controller. All HFO pipework is trace heated by small bore steam pipes laid adjacent to the HFO pipe and encased in the same insulation.

Fuel oil from the HFO service tank, is supplied to one of two boiler FO booster pumps via a filter and flow meter. The second pump will be on automatic standby and will start in the event of a discharge pressure drop to 16kg/cm2 or a voltage failure of the running pump.

A pressure control valve, with its sensing point at the boiler fuel inlet line, maintains the pump discharge pressure by recirculating oil from the pump discharge back to the FO return pipe. The oil in the FO return pipe flows back to the pump suction after the flow meter. The vent from the FO air pipe vents to the HFO overflow/drain tank vent. This line will normally only carry air/gas and will not affect the flow meter reading.

The boiler FO booster pumps discharge through one of a pair of FO heaters where the oil is heated to the required temperature.

The oil is fed to each boiler via a flow control valve, controlled by the boiler control system. When the boilers are in a standby condition, a solenoid controlled three-way valve automatically operates to circulate fuel back to the return pipe through line OF309, keeping the FO at working temperature immediately before the burner. The system also has the facility to divert the returned oil back to the HFO settling tanks through an automatically controlled three way valve number OF312F.

Two boiler ignition pumps take suction from the MDO service tank via the pipe line leading away from quick closing valve OD101F.

Preparation for the Operation of the Auxiliary Boiler Fuel Oil Service System

a- Ensure that the system fuel oil filters are clean.
b- Ensure that all instrumentation valves are open.

The following procedure illustrates starting from cold with the system charged with MDO and in a shut down condition.

c- Set up the valves as in the following table:

Position	**Description**	**Valve**
Open	HFO service tank suction quick-closing valve	OF201F
Open	No.1 HFO settling tank suction quick-closing valve	OF051F
Open	No.2 HFO settling tank suction quick-closing valve	OF052F
Set	Three-way suction valve from HFO settling tanks	OF053F
Open	Line valve from HFO service tank	OF301F
Closed	Line valve from HFO settling tanks	OF302F
Open	MDO service tank suction quick-closing valve	OD101F
Open	Line valve from MDO service tank	OD301F
Set	Three-way pump suction valve set for DO	OF318F
Open	Inlet valve to flow meter	OF304F
Open	Outlet valve from flow meter	OF306F
Closed	Flow meter bypass valve	OF307F
Open	No.1 boiler FO pump suction valve	OF308F
Open	No.1 boiler FO pump discharge valve	OF310F
Open	No.2 boiler FO pump suction valve	OF309F
Open	No.2 boiler FO pump discharge valve	OF311F
Closed	Pump discharge cross-connection valve	
Open	Pressure regulating valve inlet valve	
Open	Pressure regulating valve outlet valve	
Open	Pressure regulating valve bypass valve	
Closed	No.1 FO heater inlet valve	OF312F

Closed	No.1 FO heater outlet valve	OF315F
Closed	No.2 FO heater inlet valve	OF313F
Closed	No.2 FO heater outlet valve	OF316F
Open	FO heater bypass valve	OF314F
Closed	Both FO heater vent valves	
Closed	Both FO heater drain valves	
Open	No.1 boiler inlet valve	
Open	No.1 boiler FO return valve	
Open	No.2 boiler inlet valve	
Open	No.2 boiler FO return valve	
Set	Return pipe three-way valve set to return pipe	
Open	Return pipe outlet valve to pump suction	OF317F
Open	No.1 pilot burner pump suction valve	
Open	No.1 pilot burner pump discharge valve	
Open	No.2 pilot burner pump suction valve	
Open	No.2 pilot burner pump discharge valve	
Open	No.1 boiler pilot burner inlet valve	
Open	No.2 boiler pilot burner inlet valve	

Procedure to Start Up the Boiler Fuel Oil Service System and Change Over to Heavy Fuel Oil

a- Start one boiler FO booster pump and one boiler DO ignition pump.
b- Flash up the boiler on MDO using atomising air (see section 2.2.2 Boiler Control System).

When steam is available:

a- Open the supply of steam heating to the HFO service tank.
b- Open the supply of trace heating to the FO service system pipelines.

Note: Trace heating should not be applied to sections of pipeline isolated by closed valves on the FO side, as damage, such as ruptured flange joints, could occur due to the expansion of the contents.

When sufficient steam pressure is available:

a- Stop firing the boiler.
b- Open the selected FO heater inlet and outlet valves and close the heater bypass valve, OF314F.
c- Manually start supplying steam to the selected on-line FO heater.
d- Operate the boiler FO booster pump suction three-way valve OF318F to take suction from the HFO service tank.
e- Close the MDO suction line valve OD301F.
f- Resume firing the boiler using atomising air.
g- Continue to raise the FO temperature manually.
h- Change the operation of the heater steam control valve to AUTO and open the steam inlet valve fully.

i- When heated HFO is circulating through the system and the boiler is firing normally, change to steam atomizing.

The boiler is designed to operate and remain on standby using HFO. A changeover to MDO is only necessary when maintenance is required and for long periods of shut down, such as during refits.

j- After the boiler is firing on HFO, put the other FO booster pump on automatic start.

Note: Do not change to steam atomizing until the system is charged with HFO as this could lead to unstable flame conditions due to incorrect temperature settings at the heater.

2.6.4 INCINERATOR FUEL OIL SYSTEM

Introduction

The incinerator burner is supplied with diesel oil from its own incinerator MDO service tank which is replenished from the DO service tanks by the generator engine DO pump. MDO is used in the incinerator to burn garbage and to assist in the burning of waste oil by raising the furnace temperature to a high level.

The incinerator waste oil tank is supplied with waste oil from the separated bilge oil tank, the main engine scavenge air drain tank, the LO drain tank, the stuffing box LO drain tank, the FO overflow drain tank and the FO purifier sludge tank, by means of the sludge pump. The sludge pump has an automatic stop facility via the high level switch on the incinerator waste oil service tank.

The waste oil is supplied to the incinerator by means of the waste oil circulating pump which also circulates waste oil back to the tank to ensure correct temperature distribution and mixing. Water may be drained from the waste oil service tank by means of a self closing test cock, OF426F.

Procedure for Filling the Incinerator Marine Diesel Oil Service Tank

a- Check the quantity of diesel oil in the incinerator MDO tank and calculate how much diesel oil needs to be transferred.
b- Open the quick-closing suction valve OD101F. The DO service tank valve is normally kept open.
c- Open the suction and discharge valves on the generator engine DO pump. These valves are normally left open.
d- Close the generator engine DO pump discharge line valve to the generator engines and open the discharge valve to the incinerator DO service tank line.
e- Open the incinerator DO service tank inlet valve OD353F and ensure that the filling valve OD357F to the emergency generator DO tank is closed and that the topping up generator DO tank filling valve is closed.
f- Start the generator engine DO pump either locally or remotely from the control room console and transfer the desired quantity of diesel oil to the incinerator DO service tank. Any excess will overflow back to the MDO service tank through a spill line.

When the desired quantity has been transferred, stop the pump, close the line valve to the incinerator DO service tank and open the line valve to the generator engines. Record the details of the transfer in the Oil Record Book.

Procedure for Transferring Waste Oil to the Incinerator Waste Oil Settling Tank

The description assumes that waste oil is being taken from the separated bilge oil tank and pumped to the waste oil tank using the sludge pump.

a- Check the quantity of waste oil in the incinerator waste oil service tank and determine the quantity of waste oil to be transferred.
b- Set the valves as in the following table.

Position	Description	Valve
Open	Sludge pump suction valve from separated bilge oil tank	BG301F
Closed	Sludge pump suction valve from other tanks	BG302F
Closed	Sludge pump recirculation valve	BG304F
Closed	Stuffing box LO drain tank suction valve	OL405F
Closed	LO drain tank suction valve	OL406F
Closed	Scavenge drain tank suction valve	OL434F
Closed	FO overflow/drain tank suction valve	OF419F
Closed	FO purifier sludge tank suction valve	OF421F
Closed	Sludge pump discharge valve to separated oil tank	BG305F
Closed	Shore discharge valves	
Open	Sludge pump discharge line valve	BG306F
Open	Incinerator waste oil tank inlet valve	OF357F

c- Start the sludge pump from the local position on AUTO by pressing the START pushbutton. The pump will stop automatically when the level in the waste oil service tank reaches the stop level switch. The incinerator waste oil tank overflows to the separated bilge oil tank in the event of the pump not stopping.

Note: IF the contents of the sludge tanks, separated oil tank or scavenge drain tank are to be transferred to the incinerator waste oil tank the procedure is the same except for the setting of the sludge pump suction valves.

All oil transfers made in this way must be recorded in the Oil Record Book.

Procedure for Preparing the Incinerator Waste Oil and Diesel Oil Systems

a- Drain water from the incinerator MDO service tank by opening the self-closing test valve OD408F until no water is observed.
b- Open the incinerator MDO service tank quick closing outlet valve OD351F.
c- Open the diesel oil inlet valve to the incinerator OD355F.

The incinerator DO system is now ready for operation.

d- Apply steam heating to the incinerator waste oil tank and allow the contents of the tank to settle for at least six hours.

e- Drain any water from the waste oil service tank by opening the drain valve OF425F and the self-closing drain valve OF426F.
f- Open the incinerator waste oil service tank quick-closing outlet valve OF351F. Open the waste oil circulation pump suction valve OF352F and outlet valve OF353F. Open the waste oil recirculation valve OF354F.
g- Supply trace heating to the waste oil pipework system.
h- Start the waste oil circulation pump. Waste oil will be taken from the waste oil service tank and returned to the same tank. When the incinerator waste oil tank achieves the correct temperature, the waste oil is ready to burn in the incinerator.
i- Start the incinerator operating (see section 2.14.6 Incinerator and Garbage Disposal).
j- When the incinerator is warmed through on diesel oil, open the incinerator waste oil return valve OF356F and supply valve OF355F. Close the waste oil recirculation valve OF354F.

The incinerator is now able to burn waste oil.

2.6.5 EMERGENCY GENERATOR FUEL OIL SYSTEM

Emergency Generator Engine Diesel Oil System

The emergency generator engine uses MDO which is stored in the emergency diesel generator oil storage tank. This tank has a capacity of 2.5m3 which is sufficient for 24 hours full load running of the emergency generator.

The service tank is normally filled via a filling line located above the tank on B deck from oil drums but can be filled in an emergency from the engine room generator diesel oil pumps.

The correct grade of fuel must be used when the ship is operating in cold climate conditions.

Procedure for Transferring Diesel Oil to the Emergency Diesel Generator Service Tank

a- Check the level of oil in the emergency generator engine MDO service tank and determine how much MDO is to be added.
b- Ensure that oil spill precautions are taken.
c- Open the filling connection at B deck and connect the filling hose from the hand transfer pump which has the suction pipe located in the drum containing the MDO.
d- Operate the hand pump until the required quantity of MDO has been transferred.
e- Remove the hose and close the filling connection.
f- Remove the hand pump suction line from the drum, close the drum and lash the drum securely.

The tank is fitted with a self-closing sludge cock for draining water from the tank and if over filled overflows back to the DO service tank.

Procedure for Transferring Diesel Oil to the Emergency Diesel Generator Service Tank using the Generator Engine Diesel Oil Pump

a- Check the level of DO in the emergency diesel generator MDO service tank and determine the amount of MDO to be transferred.

b- Open the emergency diesel generator service tank filling valve OD357F and remove the blank at the valve if it has not already been removed. Ensure the incinerator MDO service tank inlet valve, OD353F, is closed.

c- Ensure that the filling valves for the topping up generator tank and the Incinerator MDO tank are closed.

d- Open the MDO service tank quick-closing outlet valve OD101F and the generator engine pump suction valve. These valves are normally left open.

e- Close the generator engine pump discharge line valve to the generator engines and open the discharge line valve to the incinerator and emergency generator engine tanks.

f- Start the generator engine MDO pump and transfer the required amount of diesel oil to the emergency generator service tank.

The tank will overflow back to the service tank when full and this can be witnessed at the sight glass located near the pump.

g- When the transfer is complete stop the pump and close the emergency generator MDO service tank filling valve and replace the blank. Close the generator engine MDO pump line valve to the incinerator and emergency generator MDO tanks and re-open the line valve to the generator engines.

2.7 Fuel Oil and Diesel Oil Transfer Systems

2.7.1 Fuel Oil and Diesel Oil Bunkering and Transfer System

2.7.2 Fuel Oil and Diesel Oil Purifying System

2.7 FUEL OIL AND DIESEL OIL TRANSFER SYSTEMS

2.7.1 FUEL OIL AND DIESEL OIL BUNKERING AND TRANSFER SYSTEM

- **Heavy Fuel Oil Transfer Pump**
- Maker: Taiko Kikai Industries
- Model: VG-25MA
- No. of sets: 1
- Capacity: 25m3/h at 3.0kg/cm2 and 1,200 rpm

Marine Diesel Oil Transfer Pump

- Maker: Taiko Kikai Industries
- Model: NHG-10MA
- No. of sets: 1
- Capacity: 10m3/h at 3.0kg/cm2 and 1,200 rpm

Introduction

Heavy fuel oil (HFO) for all on board purposes, is stored in four HFO bunker tanks. From the bunker tanks the oil is transferred to two settling tanks where it is allowed to settle prior to being purified into the service tank. HFO is supplied to the main engine and generator engines from this service tank. The boilers can be supplied from either the settling tanks or the service tank.

The HFO bunker tanks are filled from a fuel oil bunkering line located at the cargo manifolds on the port and starboard sides of the ship. There are two connections to each manifold at the midship point. Sampling valves are fitted at each bunker pipe connection point before the bunkering manifold valve on each pipe. The bunkering line is fitted with a relief valve set at 5.0kg/cm2, the discharge from which flows into the FO overflow/drain tank.

There is one heavy fuel oil transfer pump which is used to transfer HFO from the bunker tanks to the HFO settling tanks at a maximum rate of 25m3/h and a pressure of 3.0kg/cm2. The marine diesel oil (MDO) transfer pump of capacity 10m3/h and a pressure of 3.0kg/cm2 is dedicated to the transfer of MDO from the MDO storage tank to the MDO service tank. In an emergency it is possible to use the pump dedicated to MDO for HFO pumping, and the HFO pump for MDO, provided that blanks are removed.

The HFO transfer pump is started and stopped automatically by means of level switches on the HFO settling tanks: the operating tank being selected as required at the pump's group starter panel on the main switchboard. The MDO transfer pump is stopped automatically by means of a level switch on the MDO service tank. HFO is transferred to the HFO service tank by the HFO separators.

A FO overflow/drain tank of 44.5m3 capacity is provided and is designed to collect the overflow from the HFO settling tanks in the event of overfill. The MDO service and storage tanks also overflow to this tank. The HFO transfer pump is used to pump its contents up to the HFO bunker or settling tanks.

Fuel oil can be transferred from one bunker tank to another for trim or other purposes, using the transfer pump and the bunkering line. The settling and service tanks can also be drained to the overflow tank provided that blanks are removed.

The outlet valves from the fuel tanks are all remote operated quick-closing valves with a collapsible bridge which are pneumatically operated from the fire control station. After being tripped, the valves must be reset locally. Each tank is also fitted with a self-closing test cock to test for and drain any water present. Tundishes under these test cocks drain any liquid to the bilge primary tank.

All of the tanks are provided with local temperature gauges but in addition, remote level and temperature indicators are fitted in the control room. The tanks also have an overfill alarm.

All HFO tanks are fitted with heating coils, the heating steam being supplied at 7.5kg/cm2 from the heating steam system. Condensate from the heating coils flows to the atmospheric dump condenser and then to the feed filter tank via an oil detector and observation tank. All HFO transfer lines are trace heated by steam also at 7.5kg/cm2.

Fuel Oil System Tanks

Heavy Fuel Oil Tanks

Compartment	**Capacities (SG 0.980) Volume 100% (m3)**	**Weight 95% (m3)**
No.1 HFO storage tank (stbd)	1,268.9	1,205.5
No.2 HFO storage tank (stbd)	416.5	395.7
No.1 HFO storage tank (port)	1,193.1	1,133.5
No.2 HFO storage tank (port)	664.9	631.7
No.1 HFO settling tank	93.2	88.5
No.2 HFO settling tank	81.7	77.6
HFO service tank	82.3	78.2
HFO overflow tank	44.5	
	Total: 3,800.6	**3,610.6**

Preparation and Procedure for the Loading and Transfer of Bunkers

Prior to bunkering, the Chief Engineer should confirm that the specification of the fuel oil being delivered is the same as that ordered and that the quantity being supplied is also that which was requested.

Before and during bunkering, the following steps should be complied with:

a- The purpose of this procedure is to ensure that bunkers of the correct specification and quantity are received on board in a safe and efficient manner, which minimises the risk of pollution.
b- Shore and barge tanks should be checked for water content.
c- Representative samples are to be drawn using the continuous drip method for the duration of the loading operation and they are to be immediately dispatched for laboratory analysis.
d- Where possible, new bunkers are to be segregated on board prior to use until results of the laboratory analysis are received.
e- No internal transferring of bunkers should take place during bunker loading operations unless permission has been obtained from the Chief Engineer.
f- The Chief Engineer should calculate the estimated finishing ullages/dips, prior to the starting of loading.
g- HFO storage tanks should not exceed 95% full.
h- Any bunker barges attending the vessel are to be safely moored alongside before any part of the bunker loading operation begins.
i- The overfill level alarms fitted to bunker tanks should be tested prior to any bunker loading operations.
j- Verify that all lines are sound, by visual inspection.
k- Complete the pre-transfer checklist.
l- All personnel involved should be aware of the contents of the Chief Engineer's bunker loading plan.
m- The Chief Engineer is responsible for bunker loading operations, assisted at all times by a sufficient number of officers and ratings to ensure that the operation is carried out safely.
n- A watch for signs of leakage should be kept at the manifold during loading.
o- All personnel involved should be in radio contact, the radios being tested prior to the bunkering operation.
p- The maximum pressure in the bunker line should be below 5.0kg/cm2, at which point the line relief valve will discharge to FO overflow/drain tank.
q- Safe means of access to barges/shore shall be used at all times.
r- Scuppers and save-alls (including those around bunker tank vents) should be effectively plugged.
s- Drip trays are provided at bunker hose connections.
t- Oil spill containment and clean up equipment must be deployed and ready for use.

u- Loading should start at the agreed minimum loading rate. Only upon confirmation of no leakage and fuel going only into the nominated tanks, should the loading rate be increased.

v- When topping off, the flow of oil to the tank in question should be reduced by diverting the flow of oil to another tank. In the case of the final tank, the loading rate should be reduced to the agreed minimum at least 20 minutes before the finishing ullage is reached.

w- Prior to bunkering, the operation must be discussed with the bridge team where any matters which are likely to interfere with bunkering must be raised. All shipboard personnel must be made aware that bunkering is to take place.

Caution Note: At least one bunker tank filling valve must be fully open at all times during the bunkering operation.

Relevant information is to be entered in the Oil Record Book on completion of loading.

Procedure to Load Bunkers from Shore/Barge

a- At the bunker connection to be used, remove the blank and connect the bunkering hose. Ensure that the joint being used is in good condition.

b- Ensure that the blanks on the other bunkering connections are secure and that the valves are closed, with drain and sampling valves closed, also that the drip tray is empty and drain closed.

c- Open the filling valve(s) on the fuel oil bunker tanks to be filled.

Description	Valve
No.1 HFO storage tank (starboard)	OF512F
No.2 HFO storage tank (starboard)	OF514F
No.1 HFO storage tank (port)	OF511F
No.2 HFO storage tank (port)	OF513F

d- Open the valve at the selected bunkering connection at the cargo manifold.

Description	Valve
Manifold port forward	OF501F
Manifold port aft	OF502F
Manifold starboard forward	OF503F
Manifold starboard aft	OF504F

e- Establish effective communication between the control room and the bunker barge or bunkering shore station.

f- Signal to the bunker barge or shore station to commence bunkering fuel oil at an agreed slow rate.

g- Check the ship to barge or shore connection and pipeline for leaks.

h- Check that fuel oil is flowing into the required fuel oil storage tank(s), and not to any other tank. Check that the drip sampler unit is operating at the required rate.
i- Increase bunkering to the agreed maximum rate for the line which is 500m3/h.
j- As the level in the first fuel oil bunker tank approaches 90%, close in the filling valve to top up the tank slowly, then close the filling valve completely when the required level is reached.

Always ensure another bunker tank filling valve is open before closing in to top a tank off.

k- Repeat the above until only two tanks remain open, then signal to bunker barge/shore to reduce the pumping rate.
l- When filling the final tank, signal a further flow reduction until the tank is at the required level and then signal to stop.
m- Close the valve at the bunkering connection.
n- Open the vent at the bunkering connection and allow the hose to drain back to the supplier.
o- Disconnect the hose connection and replace the blank.
p- Close the tank filling valves.
q- Collect and label samples and send ashore for laboratory testing.
r- When the oil bunkering is completed close all valves and record the transfer in the Oil Record Book.

Procedure for the Transfer of Heavy Fuel Oil from the Storage Tanks to the Settling Tank(s) using the Heavy Fuel Oil Transfer Pump

Under normal circumstances the HFO transfer pump is set to automatic operation to fill the HFO settling tank(s). The pump is started and stopped by float switches in the tank. Pump and line valves will be set to allow for automatic operation; one of the two HFO settling tanks is selected as the automatic operating tank, the operating tank being selected as required at the pump's group starter panel on the main switchboard.

The duty engineer must ensure that there is sufficient HFO in the operating HFO storage tank when the vessel is operating in UMS mode. If there is insufficient HFO the engineer must be prepared to change over HFO storage tanks.

The procedure below is for manual transfer of HFO to the HFO settling tanks. The procedure assumes that No.2 HFO settling tank is selected and that the transfer pump is switched for automatic operation.

a- Check the levels in the tanks from which oil is to be taken and to which oil is to be transferred. Calculate the amount to be transferred
b- Open the suction valves from the bunker tank to be transferred.

Description	Valve
HFO overflow tank	OF007F
No.1 HFO storage tank (port)	OF001F
No.2 HFO storage tank (port)	OF002F
No.1 HFO storage tank (starboard)	OF003F
No.2 HFO storage tank (starboard)	OF004F
Port tanks line suction valve	OF005F
Starboard tanks line suction valve	OF006F

c- Open the HFO transfer pump discharge valves and HFO settling tank valves as in the following table.

Position	Description	Valve
Open	HFO transfer pump discharge valve	OF010F
Closed	HFO transfer pump discharge valve to bunker tanks	OF016F
Closed	No.1 HFO settling tank inlet	OF013F
Open	No.2 HFO settling tank inlet	OF015F

d- Start the fuel oil transfer pump manually at the local control panel.

e- Check that fuel oil is being correctly transferred, i.e. that it is being transferred from the required storage tank to the No.2 HFO settling tank.

f- Stop the pump when the required amount of oil has been transferred.

g- Close all valves at the end of the operation.

Under normal operation the transfer pump will remain lined up to the selected operating settling tank and it will be selected for automatic operation at the pump controller. The pump will start and stop automatically, controlled by the settling tank level switches.

Procedure for the Transfer of Heavy Fuel Oil between the Bunker Tanks

HFO may be transferred between bunker tanks if required in order to adjust the trim of the vessel. The procedure is similar to that for manual transfer of HFO from bunker tanks to the HFO settling tank.

a- Follow steps a- to c- in the above procedure selecting the valves for the tank from which HFO is to be transferred and the pump which is to be used for the transfer.

b- Set the HFO transfer pump discharge valves as in the following table.

Position	Description	Valve
Open	HFO transfer pump discharge valve	OF010F
Open	HFO transfer pump discharge valve to bunker tanks	OF016F
Open	Bunker line supply valve	OF515F

Closed	No.1 HFO settling tank inlet	OF013F
Closed	No.2 HFO settling tank inlet	OF015F

c- Open the filling valve for the bunker tank to which HFO is to be transferred. Check that all other bunker line valves are closed and that the blanks are securely attached at the bunker station.

d- Determine how much HFO is to be transferred.

e- Start the HFO transfer pump manually and check that HFO is being pumped between the correct bunker tanks.

f- When the desired amount of HFO has been transferred stop the HFO transfer pump and close all valves.

Marine Diesel Oil System

There is one marine diesel oil (MDO) storage tank (130.9m3) and one MDO service tank (34.4m3). The MDO is transferred from one to the other using the MDO transfer pump. An alternative arrangement is to use the CJC filter separator to transfer MDO from the MDO storage tank to the MDO service tank. The CJC filter separator would normally be used to filter diesel oil from the MDO service tank and return it to that tank.

The MDO storage tank is filled from a dedicated MDO bunkering line located at the cargo manifolds on the port and starboard side of the vessel. The bunkering line is fitted with a relief valve set at 5.0kg/cm2 and discharges into the MDO storage tank. The transfer pump is used to transfer oil from the storage tank to the service tank at a rate of 10m3/h and a pressure of 3.0kg/cm2. The pump is normally started manually and stopped automatically by a level switch in the service tank but may also be operated completely manually if required.

The MDO service tank overflows to the FO overflow drain tank.

Diesel Oil System Tanks

Compartment	**Capacities (SG 0.900) Volume 100% (m3)**	**Weight 95% (m3)**
DO storage tank	130.9	124.4
MDO service tank	34.4	32.7
	Total: 165.3	**157.0**

All of the outlet valves on the diesel tanks are remotely operated quick-closing valves with a collapsible bridge which are pneumatically operated from the fire control station. After being tripped from the fire control station the valves must be reset locally. The service tank is fitted with a self-closing test cock to test for the presence of water and to drain any water present.

Tundishes under the self-closing test cocks drain any liquid to the bilge primary tank.

All of the tanks are provided with local indication, plus remote level/capacity indication on the UCS 2100 FO Transfer System screen display and the Saab tank radar system miscellaneous screen display. The storage tanks also have an independent overfill alarm set at 98.5% capacity.

Preparation for the Operation of Bunkering Diesel Oil

The procedures for bunkering MDO are as described for HFO and should be followed.

To Load Bunkers From Shore/Barge

At the bunker connection to be used, remove the blank and connect the bunkering hose. Arrange a drip tray beneath the connection.

- a- Ensure that the blanks on the other bunkering connections are secure and that the valves are closed. Ensure that the drain and sampling valves are closed.
- b- Open the filling valve on the DO storage tank OD511F.

Note: Normally the MDO storage tank will be filled when bunkering but it is possible to fill the MDO service tank by opening the MDO service tank filling valve OD005F and the line valve OD006F between the MDO transfer pump and the bunker line.

- c- Open the valve at the bunkering connection at the cargo manifold: OD501F at the port manifold or OD504F at the starboard manifold.
- d- Check that the correct valves are open for the tank to be filled.
- e- Establish effective communication between the control room and the bunkering barge/shore station.
- f- Signal to the barge/shore station to commence bunkering diesel oil at an agreed slow rate.
- g- Check the ship to barge/shore connection and pipeline for leaks.
- h- Check that DO is flowing into the required diesel oil storage tank(s), and not to any other tank.
- i- Speed up bunkering to the agreed maximum rate.
- j- As the level in the diesel oil storage tank approaches 90%, signal to the barge/shore to further reduce the flow rate until the tank is 95% full and then signal to stop.
- k- Close the valve at the bunkering connection.
- l- Open the vent at the bunkering connection and allow the hose to drain back to the supplier.
- m- Disconnect the hose connection and replace the blank.
- n- Close all the tank filling valves.
- o- When the oil bunkering is completed close all valves and record the transfer in the Oil Record Book.

To Transfer Diesel Oil Using the Diesel Oil Transfer Pump

a- Open the suction valve at the MDO storage tank OD001F.
b- Set the pump valves and the tank filling valves as in the following table.

Position	Description	Valve
Open	MDO transfer pump suction valve	OD002F
Open	MDO transfer pump discharge valve to MDO service tank	OD004F
Open	MDO service tank filling valve	OD005F
Closed	MDO transfer pump line valve to HFO tanks	OF018F
Closed	MDO transfer pump line valve to bunker line	OD006F

c- Start the MDO transfer pump.
d- Check that MDO is being correctly transferred.

The transfer pump will stop automatically when the service tank reaches the required level provided that the pump is selected for automatic operation.

e- Alternatively, stop the pump when the required amount of oil has been transferred.

Emergency Generator Fuel Oil System

The emergency generator engine uses MDO which is stored in the emergency diesel generator oil storage tank. The tank has a capacity of 2.5m3 which is sufficient for 24 hours full load running of the emergency diesel generator engine.

The emergency generator engine MDO service tank is normally filled via a filling line located above the tank on B deck. The tank is filled from oil drums using a hand pump.

Procedure for Transferring Diesel Oil to the Emergency Diesel

Generator Service Tank

a- Check the level of oil in the emergency generator engine MDO service tank and determine how much MDO is to be added.
b- Ensure that oil spill precautions are taken.
c- Open the filling connection at B deck and connect the filling hose from the hand transfer pump which has the suction pipe located in the drum containing the MDO.
d- Operate the hand pump until the required quantity of MDO has been transferred.
e- Remove the hose and close the filling connection.
f- Remove the hand pump suction line from the drum, close the drum and lash the drum securely.

The emergency generator service tank may be filled in an emergency, from the MDO service tank by the generator engine MDO pump. If overfilled, the tank overflows back to the main MDO service tank.

The emergency generator service tank is also fitted with a self-closing sludge cock for draining water from the tank down to the bilge primary holding tank.

Procedure for Transferring Diesel Oil to the Emergency Diesel Generator Service Tank using the Generator Engine Diesel Oil Pump

a- Check the level of MDO in the emergency diesel generator service tank and determine the amount of diesel to be transferred.

b- Open the emergency diesel generator service tank filling valve OD357F and remove the blank at the valve. Close the incinerator MDO service tank inlet valve OD353F.

c- Open the MDO service tank quick-closing outlet valve OD101F and the generator engine MDO pump suction valve. These valves are normally left open.

d- Close the generator engine MDO pump discharge line valve to the generator engines and open the discharge line valve to the incinerator and emergency generator engine tanks.

e- Start the generator engine MDO pump and transfer the required amount of fuel to the emergency diesel generator service tank.

The tank will overflow when full and this can be recognized at the sight glass located near the pump.

f- When the transfer is complete stop the pump and close the emergency generator service tank filling valve OD357F, and replace the blank. Close the generator engine MDO pump discharge valve to the incinerator and emergency generator line and open the line valve to the main generator engines.

2.7.2 FUEL OIL AND DIESEL OIL PURIFYING SYSTEM

Fuel Oil Separator

- Maker: Westfalia
- No. of sets: 2
- Capacity: 3,300 litres/hour
- Model: OSD35-0136-067 design 25
- Motor: 440V, 18.5kW at 3,600 rpm
- Bowl speed: 8,200 rpm
- Separating temperature: 98°C
- Control panel: Simatic C7-623/P

Fuel Oil Separator Pumps

- Maker: Taiko Kikai Industries
- No. of sets: 2
- Model: NHG-4MA
- Capacity: 3,300 litres/h at 2.5kg/cm2

Marine Diesel Oil Off-line Filter Separator

- Maker: CJC Filters
- No. of sets: 1
- Model: PTU1 27/108 MZ-EPWYZ
- Type: Filter inserts 2 x 27/27
- Capacity: 600 litres/h
- Pump: 710 litres/h
- Controller ID: 55604/411093

Introduction

The HFO system operates with two centrifugal separators and the MDO system operates with the CJC filter separator which is fitted with its own circulating pump.

For the centrifugal separation of HFO there are two separators. Under normal circumstances one separator will be operating to fill the HFO service tank from the HFO settling tanks as fuel is being used by the main and generator engines.

Both HFO purification systems are identical and comprise a centrifugal separator with its own dedicated supply pump and heater. A common sludge tank is provided for the separator system. The separators have a maximum throughput of 3,300 liters/hour and the supply pumps are rated at 3,300litres/ hour at 2.5kg/cm2.

The separators are of the self-cleaning type and the bowls automatically open to discharge sludge at timed intervals.

Centrifugal separation is improved when the difference in relative density between the fuel, water and solids in the fuel are as great as possible and the difference in relative densities can be increased if the temperature of the fuel being treated is raised. Manufacturer's recommendations with respect to operating temperatures should always be followed. The temperature of the fuel flowing to the separators can be adjusted by the thermostat control on the heater control unit.

Separator Operation

Warning Note: Care must be taken when operating the separator system. Hot oil and steam are present and can result in serious injury if leakage occurs.

There is a fire risk from the presence of hot oil and all precautions must be taken to prevent a fire and to deal with one should an outbreak occur.

The extinguishing system must be checked frequently.

Caution Note: Centrifuges operate on an automatic sludging system but failure of the system to effectively discharge sludge can cause overload and subsequent breakdown of the bowl arrangement which rotates at high speed. After manual cleaning, care is needed to ensure that the bowl is assembled correctly, as incorrect assembly can result in disintegration at high rotational speed. All operating and maintenance precautions stipulated by the manufacturer in the maintenance manual must be observed.

Liquid mixtures and solid/liquid mixtures can be separated by two methods, the gravity field of a settling tank or the centrifugal field of a separator bowl. Both systems rely on the product components having different densities. Since the centrifugal force of a separator is considerably more effective than the gravity field of a settling tank it is usual practice to favor the centrifugal force method. The heated dirty oil enters the separator and the centrifugal force created by the rotating bowl causes the liquid mixture to separate into its different constituents within the disc stack.

The solid particles suspended in the oil settle on the underside of the discs and slide down into the solid holding space. The smooth disc surfaces allow the solids to slide down and provide self-cleaning of the discs. Each bowl assembly is fitted with a separating disc which can be configured in order for the separator to act as a clarifier or a separator. There are two locations in the separating disc in which threaded pins can be inserted. When they are in place the unit acts as a clarifier, when they are removed the unit acts as a separator.

Being of the self-cleaning type, the accumulation of solids within the holding space will be ejected at predetermined intervals depending on the quality of the oil. This is achieved automatically by the control panel and a number of solenoid valves which will bypass the oil supply and open the bowl for a set period of time by the use of high pressure water.

The C7-623 control unit shown in illustration 2.7.2b is used for the automatic ejection control and condition monitoring of the HFO separator. The control unit has three modes of operation.

1- Partial ejections
2- Total ejections
3- Preselected partial ejections followed by total ejection

With the time dependant program cycle, it is important for high clarifying efficiency and to avoid desludging losses and that the separable solids content in the product do not fluctuate widely. The UNITROL system provides two basic monitoring systems.

1- Water content monitoring system (WMS)
2- Sludge space monitoring system (SMS)

The illuminated Liquid Crystal Display (LCD) provides information about the operating and malfunction condition of the separator and displays all the relevant process data.

In addition to the control cabinet the control system comprises all the complete line fittings incorporating electrical components which are controlled or monitored by the control unit which include:

• Dirty oil connection

• Water connection

• Operating water connection

• Circuit and water discharge valve

• Water sensor

• Thermometer for monitoring the dirty oil temperature

• A klaxon for sounding an audible alarm

Software assignment for a each separator is carried out in the factory using a password function. Any alterations to the set parameters should only be carried out by a person authorized to make such changes.

Caution Note: Centrifuges operate on an automatic sludging system but failure of the

system to effectively discharge sludge can cause overload and subsequent breakdown of the bowl arrangement which rotates at high speed. After manual cleaning, care is needed to ensure that the bowl is assembled correctly, as incorrect assembly can result in disintegration at high rotational speed. All operating and maintenance precautions stipulated by the manufacturer in the maintenance manual must be observed.

The HFO separators require compressed air and fresh water supplies for control and bowl operation/flushing. Supply systems for these are covered in the relevant control air system and fresh water sections respectively.

There are two centrifugal self-cleaning HFO separators fitted. Each separator has a supply pump which directs HFO through the steam heater. The separators, supply pumps and heaters are located in the separator room. Instrument air is supplied to the separators to control the supply of oil to the bowl and the automatic discharge facility. Domestic fresh water is supplied for sealing and flushing purposes.

The HFO supply pumps have a discharge crossover valve which allows either feed pump to supply either separator. The steam heaters maintain a constant temperature of 98ºC for optimum separation. From the heater the HFO is pumped into the separator. After separation, the oil is discharged to the HFO service tank.

Preparation for the Operation of the Heavy Fuel Oil Separation System

It has been assumed that the No.1 HFO separator supply pump is operating on the No.1 heater and the No.1 HFO separator, taking oil from the No.1 HFO settling tank and purifying back to the HFO service tank.

a- Ensure that the settling tank contains HFO in sufficient quantity to enable the separator to function correctly.
b- Check and record the level of oil in all fuel tanks.
c- Open the self-closing test cock OF410F on No.1 HFO settling tank, closing it again when all water has drained.
d- All valves in the separator system are to be initially closed.
e- Open the valves, as indicated in the table below, to take suction from No.1 HFO settling tank discharge to the HFO service tank.

Position	Description	Valve
Open	No.1 HFO settling tank quick-closing suction valve	OF051F
Set	Three-way suction line (set for No.1 tank)	OF053F
Closed(locked)	Line supply valve to engine supply system	OF054F
Open	No.1 supply pump suction valve	OF056F
Open	No.1 supply pump discharge valve	OF058F
Closed	Separator pump crossover valve	OF060F
Open	No.1 heater inlet valve	OF061F
Open	No.1 heater outlet valve	OF065F
Operational	Three-way recirculation valve	
Closed	Heater bypass valve	OF063F
Closed(locked)	Heater crossover valve	OF067F

Closed	Discharge valve to No.2 separator	OF068F
Open	No.1 separator outlet valve	
Open	No.1 separator outlet valve to HFO service tank	OF071F
Set	Three-way return valve to settling tanks (No.1 tank)	OF072F

Note: The separator heater steam valve, air supply valves and water supply valves must be operated as required. The above settings are for single separator operation. The separators may be operated in series with discharge from No.1 separator passing to No.2 separator before discharge to the HFO service tank. In order to allow for this operation No.1 separator discharge valve OF071F, to the HFO service must be closed and the discharge valve to No.2 separator OF068F, must be opened. No.2 separator must be set for operation.

Procedure for Operating the Separator

Caution Note: Before operating a separator a second check must be made to ensure that the correct valves are open for the separator, heater and pump to be operated as well as the tank system from which the HFO is to be drawn and the tank system to which the purified HFO is to be sent.

Separator heaters are supplied with steam as the heating medium and the drain valve from the heater must always be open. The steam supply valve is controlled by the control system and the main separator control system regulates the steam supply to give an oil temperature after the heater of 98°C.

The two HFO separators operate on the same principle using the same type of controller and so the operating procedures are the same. The following description has assumed that the No.1 HFO separator and separator feed pump are to be used for purifying from No.1 HFO settling tank to the HFO service tank.

a- Record the level of oil in all the tanks associated with the system.
b- Open any control air and operating water valves to the separator.
c- Ensure power is available to the separator controller.
d- Set the valves in accordance with the previously defined list

The separator regulating discharge valve should be set for the desired discharge pressure and should not be adjusted during normal running conditions.

e- Ensure the separator brake is off and that the separator is free to rotate.
f- Check the separator gearbox oil level.
g- Start the No.1 separator feed pump. The three way valve will ensure the oil bypasses the separator and returns to the settling tank
h- Start the separator and ensure that the bowl is up to speed before continuing.
i- Using the manual valves on the solenoid valves ensure the operating water opens and closes the bowl.

j- Switch on the control unit.
k- Slowly open the steam supply and return to the No.1 HFO heater.
l- Check that the automatic controller has taken control of the system and is maintaining the oil at the correct temperature.
m- Once the HFO temperature is above the minimum setting, start the programme by pressing PROGRAM 1 soft key on the control panel. This will initiate a start sequence including a sludge and discharge test and operate the separator in automatic mode. Once the separator is running and no signs of abnormal vibrations are evident, all temperatures and pressures should be recorded and the levels of the tanks in use checked.

Procedure to Stop the Separator

a- Press the PROGRAM 0 key. Two total ejections will be triggered and the separator will stop automatically. The HFO will be automatically recirculated through the three way valve back to the settling tank.
b- Regulate the steam to the heater and allow the oil to cool.
c- The feed pumps will need to be stopped if they are running in manual mode.
d- Close the control air and operating water valves to the separator along with any other valves opened prior to start up.
e- Once the separator has come to a complete stop the brake can be applied and preparations made for cleaning if required.

The above description of the separation operation has been related to the operation of No.1 separator. Should No.2 separator be required, careful consideration to piping diagrams and valve positions should be given before any operations are started. Refer to illustration 2.7.2a above.

Note: It is essential that the separator manufacturer's instructions regarding the stopping and dismantling of the separator are followed exactly to avoid the risk of damage. Separator bowls rotate at very high speed and any imbalance or loose connection can have serious consequences.

Diesel Oil Filter Separator System

Diesel oil is treated in the CJC filter separator unit with MDO being taken from and returned to the service tank.

The filter unit is fitted with an integral pump that pumps MDO through the filter unit.

The pump fills the filter housing with oil and forces it through the filter element to the centre of the unit. The oil then drains to the coalescing section in the filter base where any water present will separate out to the lowest part. As the water accumulates, it is collected in an externally mounted water discharge unit that is fitted with a float. When the float rises and makes a contact, the automatic solenoid valve opens and discharges the water to the primary bilge tank.

When the unit is put into operation with new filter elements, the pressure drop is small but should be recorded from the local gauge. As the filter becomes clogged this differential pressure will increase but should not be allowed to go above 2.0 bar. When it has reached this, the disposable elements must be replaced however the unit is protected with a differential pressure switch that will switch off the supply pump if the pressure is allowed to rise to 2.3 bar.

During initial start up, a small increase in pressure may be observed for approximately one hour until the flow and temperature of the oil has been stabilized.

Warning Note: Used filter elements often contain harmful substances that have been separated out from the oil. The filters must therefore be handled with caution and disposed of in the correct manner.

Procedure for Filtering Diesel Oil via the CJC Filter Separator

a- Ensure that the MDO service tank contains sufficient MDO, replenish it if necessary. The filter unit will work most effectively if the tank is filled to near its maximum capacity.
b- Open the self-closing test cock OD404F on the MDO service tank, closing it again when any water has drained.
c- Open the CJC filter separator inlet valve OD054F, the pump suction valve and the filter outlet valve OD056F.
d- Open the MDO service tank quick-closing outlet valve OD051F and the crossover line suction valve OD053F. The MDO storage tank quick-closing outlet valve OD052F should be closed.
e- Switch on the CJC filter separator. The manufacture at this point recommends that approximately 1 to 2 liters of water are initially to the unit in order to test the float switch and solenoid outlet valve. In order to add water to the unit, the vent float assembly on the top of the filter casing must be removed and water added. When the control panel indicates that the water high level alarm has been reach and the discharge solenoid valve has opened, the vent float unit can be replaced.
f- When the water level control has been tested and the vent float unit replaced, start the CJC filter pump. Cleaned MDO will be taken from and returned to the MDO service tank. The CJC filter should be operated so that all MDO in the service tank is effectively

cleaned. The time required will depend upon the quantity of MDO in the tank and the initial cleanliness of the oil.

g- To stop the unit turn the main switch on the control panel anticlockwise o the 'O' position. The green RUNNING light will go out and no other indicator will be lit. Close the system valves and isolate the power supply.

The CJC filter separator may be used for transferring MDO from the storage tank to the service tank. The procedure is the same as that above except that the outlet quick-closing valve from the MDO storage tank OF052F, must be open and the crossover line suction valve OD053F must be closed to ensure that MDO is taken from the storage tank. If this procedure is used the MDO service tank must be monitored to prevent overfilling of the tank. When the MDO service tank is full the CJC filter separator must be stopped.

2.8 Lubricating Oil Systems

2 8.1 Main Engine Lubricating Oil System

2.8.2 Stern Tube Lubricating Oil System

2.8.3 Lubricating Oil Purifying Systems

2.8.4 Lubricating Oil Filling and Transfer System

2.8 LUBRICATING OIL SYSTEMS

2.8.1 MAIN ENGINE LUBRICATING OIL SYSTEM

Main Lubricating Oil Pump

- Maker: Teikoku Machinery Works Ltd
- No. of sets: 2
- Type: Centrifugal deepwell
- Model: 250TVC-A
- Capacity: 335m3/h at 4.5kg/cm2 and 1,800 rpm

Cylinder Lubricating Oil Pumps

- Maker: Bosch
- No. of sets: 2

Introduction

The main engine has two separate lubricating oil systems:

• Main bearing lubricating oil system

• Cylinder oil system

Main Bearing, Camshaft and Piston Cooling Lubricating Oil System

The main or crankcase lubrication system is supplied by one of two pumps.

One pump will be operating and the other on standby and set for automatic cut-in should there be an oil pressure reduction or pump failure. The changeover pressure is set at 3.0kg/cm2. The main Lubricating Oil (LO) pumps take their suction from the main engine sump and discharge to the engine via the main LO cooler and an automatic backflush filter. The plate type cooler is cooled by water from the low temperature central cooling fresh water system. The supply pressure in the main lubrication system is 4.5kg/cm2, and each pump has a rated capacity of 335m3/h. The main LO system supplies oil to the engine's bearings, vibration dampers and pistons where it acts as a coolant.

The cooling effect of the oil at the vibration dampers and on the underside of the piston crowns is very important. The main lubrication oil pumps also supply the camshaft system, the exhaust valve actuators and the intermediate shaft bearing. The inlet temperature to the engine is regulated to 45°C.

Turbocharger Bearing Oil System

The turbocharger bearings are supplied with LO from a line branched off the main engine LO supply rail and as such the system is common with the rest of the main engine LO system. Because of the nature of turbochargers and the high speeds at which they spin, it is essential that the turbocharger bearings receive a plentiful supply of oil at all times to prevent bearing failure. A LO reservoir is located above the turbocharger casing which is constantly fed, this reserve of oil is used by the system to ensure that oil is run down to the bearing if the engine is shutdown allowing the turbocharger protection while it is spinning down.

An oil return sight glass is provided on the turbocharger bearing outlet to provide a visual indication of oil flow.

Cylinder Lubrication System

Lubrication of the pistons and cylinders is performed by a separate Alpha cylinder lubrication system. High alkaline cylinder oil is supplied to the main engine on a once through basis. The oil lubricates the piston rings to reduce friction between the rings and liner, provides a seal between the rings and the liner and reduces corrosive wear by neutralizing the acidity of the

products of combustion. The alkalinity of the cylinder LO should match the sulfur content of the HFO supplied to the engine. The amount of cylinder oil supplied to each lubricating point can be individually adjusted and is also load dependent, the load dependent quantity adjustment being made by the engine remote control system.

From the cylinder oil storage tanks, oil is supplied to the main cylinder oil measuring tank which has a capacity 3.0m3 and from there it is directed, via a flow meter, to the small cylinder oil measuring tank, capacity 20 liters, situated below the pump unit. One of the two cylinder oil pumps is operating at all times when the engine is running with the other pump on standby. The duty pump maintains a pressure of 45 bar in the common supply rail to the cylinder lubricator units. Each cylinder has a lubricator unit has a nitrogen pressurized (25 bar) accumulator in the inlet side and another nitrogen pressurized accumulator (1.5 bar) on the outlet side. The lubricator supplies cylinder oil, in controlled quantities and at correct timing, to the six lubricator quills located around the circumference of the cylinder.

The Alpha cylinder lubrication system is microprocessor controlled and has a Master Control Unit (MCU) a Switch Board Unit (SBU) and a Back Up Unit (BCU); the MCU and BCU are supplied with 24V power from separate sources, one uninterruptable. The Human Machine Interface (HMI) panel, located in the engine console in the Cargo and Engine Control Room, allows for control of the system including manual operation of pre-lubrication.

The MCU control injection of the cylinder oil by activating a solenoid valve at the lubricator unit and feedback from each lubricator indicates to the MCU that injection has actually taken place. LEDs on the lubricator terminal box provide a visual indication of the functioning of the lubricator. Cylinder lubricating oil injection timing is based upon two signals from the angle encoder, a No.1 cylinder TDC marker and a crankshaft trigger point. The lubricator is designed to inject cylinder oil into the ring pack as the piston is moving upwards.

The amount of oil injected at each injection is constant but the frequency of injections may be varied depending upon engine operating parameters. Injection frequency is normally based upon a signal from a load transmitter (using engine MEP) and this is LOAD mode; it is possible to set the cylinder oil injection system in RPM mode.

At the HMI panel it is possible to adjust cylinder lubrication rate for each cylinder between 40% and 360% of the default 100% amount. The default rate is the basic feed rate at engine MCR.

During operation any failures are detected by the MCU and an alarm is activated. In the event of a critical failure in the MCU the BCU automatically takes over. The BCU injection is based upon random timing and RPM mode.

Injection frequency in BCU is adjustable and is normally set at the basic feed rate plus 50%. If both the MCU and BCU fail a slow down signal is sent to the engine's safety system.

A fine filter is fitted in the supply line between the two measuring tanks and fine filters are provided at the high pressure booster pump suction. The high pressure supply line to the cylinder oil manifold is fitted with a fine filter which has a differential pressure alarm. The small cylinder oil measuring tank is provided with an electric heater designed to maintain the oil temperature at 40ºC.

Waste oil from the cylinders drains to the under piston space and any liquid accumulating in this space is drained to the scavenge air space drain tank.

Procedure for Operating the Main Engine Lubricating Oil System

a- Check the oil level in the main engine sump and top up if necessary.
b- Supply steam to the main engine sump heating coil if necessary.
c- Ensure that all pressure gauge and instrumentation valves are open and that the instrumentation is reading correctly, and that the exhaust valve spring air isolating valve is open.
d- Ensure that water is flowing in the low temperature fresh water cooling system and that each LO cooler inlet and outlet valves are open.
e- Ensure that the LO cooler three-way LO bypass valve OL208F is operating correctly.
f- Set up the valves as shown in the tables below.

Position	**Description**	**Valve**
Open	No.1 LO pump discharge valve	OL203F

Open	No.2 LO pump discharge valve	OL204F
Closed	Pump discharge return to sump	OL205F
Closed	Discharge valve to LO settling tank	OL214F
Operational	LO cooler bypass three-way valve	OL208F
Open	LO cooler inlet valve	OL206F
Open	LO cooler outlet valve	O207F
Open	Automatic backflusing filter inlet valve	OL209F
Open	Automatic backflushing filter outlet valve	OL210F
Open	Bypass filter inlet valve	OL211F
Open	Bypass filter outlet valve	OL212F
Closed	Direct oil line valve to sump	OL213F
Open	Supply valve to intermediate shaft bearing	OL101F

g- Start one main LO pump.

h- Put the automatic backflush filter on line

i- Switch the other main LO pump to standby.

j- Check the pressures and temperatures throughout the system.

Caution Note: The intermediate shaft bearing which is located at frame 19.5 sits directly above the bilge holding tank, this tank is fitted with a high temperature alarm, tag No.1514 and is set at 45°C. It should be noted that excessive heating of this tank may result in the bilge holding tank structure distorting which could have serious consequences on the alignment of the intermediate bearing and shaft.

Procedure for Operating the Main Engine Cylinder Lubricating Oil System

a- Check the level of oil in the cylinder LO storage tanks and be prepared to change over tanks if necessary.

The outlets from the cylinder oil storage tanks are fitted with a quick-closing valve which must be reset manually after they have been tripped.

b- Open the tank sludge cock and drain any water from the storage tank and the large measuring tank.

c- Set up the valves as in the table below; the description assumes that No.1 cylinder oil storage tank is in use.

Position	Description	Valve
Open	No.1 cylinder oil storage tank outlet valve	OL304F
Closed	No.2 cylinder oil storage tank outlet valve	OL305F

Open	3m3 measuring tank inlet valve	OL306F
Open	3m3 measuring tank outlet valve	OL307F
Open	Flow meter inlet valve	OL308F
Open	Flow meter outlet valve	OL309F
Closed	Flow meter bypass valve	OL310F
Open	20 litre measuring tank inlet valve	
Open	No.1 cylinder oil pump inlet and outlet valves	
Open	No.2 cylinder oil pump inlet and outlet valves	
Open	High pressure filter inlet and outlet valves	
Closed	Cylinder oil manifold bypass valve	
Open	Return flow meter inlet valve	OL312F
Open	Return flow meter outlet valve	OL313F
Closed	Return flow meter bypass valve	OL314F
Open	Measuring tank return flow inlet valve	OL315F

d- At the lubricator control panel at the pump unit select each pump for LOCAL. Start both pumps both pumps; check that both pumps can run simultaneously. Stop one of the pumps so that only one pump is running.

e- Check that the pressure differential indicator on the pump station filter is green. Check that the oil pressure builds up to 45 - 50 bar and adjust the pressure control valve on top of the pump station so that the pressure is in the range 40 - 50 bar.

f- Press the PRELUBRICATION pushbutton on the HMI panel and check that the lubricators are working correctly by watching the feedback signal LEDs. Stop the pumps manually and select each pump for REMOTE operation.

g- Start the cylinder oil lubrication system operating in automatic mode by selecting AUTO at the HMI panel in the engine console in the cargo and engine control room. Press the PUMP 1 or PUMP 2 pushbutton in order to start the selected duty pump.

h- Check that the heater is activated and the oil temperature maintained at 40oC. Ensure that the lubricator pump operates and that each individual cylinder control unit is operating.

i- The Alpha cylinder lubrication system is now operational.

During operation the system must be checked for leaks and to ensure that the correct pressures are being maintained. The lubricator unit LEDs should be checked to ensure that the units are operational.

2.8.2 STERN TUBE LUBRICATING OIL SYSTEM

Stern Tube Seal

- Maker: Kobelco
- Model: DX-670 (aft seal)
- Model: CX-670 (forward seal)

Stern Tube Lubricating Oil Pump

- Maker: Taiko Kikai Industries
- No. of sets: 2
- Type: Horizontal screw
- Model: NHG-1MT
- Capacity: 1.0m3/h at 2.5kg/cm2 and 1,200 rpm

Aft Seal Lubricating Oil Supplement Pump

- Maker: Taiko Kikai Industries
- No. of sets: 1
- Type: Horizontal screw
- Model: NHG-0.2M
- Capacity: 0.2m3/h at 2.0kg/cm2 and 1,200 rpm

Introduction

The stern tube provides a bearing support for the propeller shaft as it passes through the ship's structure to the propeller. It is oil lubricated and is sealed at both ends using lip type seals. The stern tube bearing lubricating system is independent of other systems. There are three lubricating systems for the stern tube, one for the bearing unit, one for the aft seal assembly and one for the forward seal assembly. All stern tube systems use the same lubricating oil.

The stern tube assembly passes through a tank which is filled with water from the distilled water system. This provides cooling to the bearings and the stern tube.

The bearing area is lubricated by means of the stern tube LO pumps, one operating and the other on standby ready to start if the operating pump fails.

The duty stern tube LO pump pumps oil to the stern tube bearing via an oil cooler, which is cooled by fresh water circulating in the low temperature FW cooling system (see section 2.5.2). The duty pump also supplies oil to the forward seal and the after seal space between No.3 and No.3S seals. The space between No.2 and No.3 after seals is supplied with oil by the after seal LO supplement pump which has an arrangement whereby the supply may be directed by way of a high or a low valve box depending upon whether the vessel is fully loaded or in ballast. The operating condition is selected at the control panel.

Seals are provided at the outer and inner ends of the stern tube, these being designed to prevent the entry of water into the stern tube area and prevent oil leaking out to sea or into the machinery space at the forward end of the stern tube.

The aft seal consists of three parts, the four rubber lip sealing rings, the metal housing holding the sealing rings and a liner which rotates with the propeller shaft. The aftermost sealing ring is No.1 seal ring and this faces outwards, as does No.2 seal. Seal rings No.3 and No.3S both face forward. An oil supply, from either the high or low aft seal box, (depending on the loaded condition of the ship) flows to the space between the two inner stern tube seals rings, No.2 and No.3. The oil return pipe from this seal chamber is directed back to the aft seal LO supplement tank. A natural oil circulation is set up when the shaft turns thus oil flows through the seal space. The aft seal LO supplement tank is fitted with a high level alarm and if this is activated it will indicate leakage of sea water into the system.

The sealing system incorporates a standby seal 3S, which under normal operating conditions is under no load. In the event of a failure of the seal ring No.3, seal ring No.3S is used to protect the system.

The space between seal rings No.1 and 2 is filled with lubricating oil during the commissioning stage and has no direct link to the piped lubricating/sealing system.

The forward seal has two sealing rings, both facing aft, and the seal is provided with an oil supply from the stern tube lubricating oil pump. The supply is regulated to a low level and after the supply valve is adjusted it is locked; this ensures that the supply pressure to the seal will be maintained at the correct value. Oil return from the forward stern tube seal oil to the stern tube LO tank is via a flow indicator.

If the level in the stern tube LO tank falls continuously it is indicative of seal wear or damage.

Port Anti Pollution System (PAP)

To minimize the risk of oil seepage from the outer seal and resulting pollution during the vessel's stay in port, a Port Anti-Pollution system (PAP) is fitted. The PAP system consists of a control panel, a high solenoid valve panel and a low solenoid valve panel. If 'Auto' is selected on the control panel, then when a predetermined shaft revolution is reached, the automatic changeover will take place which in theory will correspond to the ship's arrival in port.

Solenoid valve E1 on the high solenoid panel closes, shutting off the oil supply to the top of the outer seal from the seal header tank. Solenoid valve E2 in the low solenoid panel closes shutting off the oil supply from the seal header tank to the bottom of the outer seal. Solenoid valve E3 in the low solenoid panel opens which releases the pressure head on the outer seal. The oil is then drained to the supplement tank. The oil can be pumped back into the system as required.

When leaving port and the predetermined shaft revolution is reached, the head is restored by the automatic closing of valve E3 and opening of valves E1 and E2.

The system can be operated manually by selecting MANUAL on the control panel and using the fill and drain switches.

Procedure for the Preparation of the Stern Tube and Seal Lubricating Oil System

a) Ensure that all instrumentation valves are open.

b) Check the oil level in the stern tube drain tank and the aft seal

LO supplement tank and top-up as necessary.

c) Set valves as shown in the table below.

2.8.3 LUBRICATING OIL PURIFYING SYSTEMS

Main Engine Lubricating Oil Purifier

- Maker: Westfalia
- No. of sets: 2
- Model: OSD 18-91-067 design 10
- Capacity: 2,300 litres/h
- Motor: 9kW at 3,600 rpm
- Bowl speed: 10,000 rpm
- Control panel: Simatic C7-623/P

Main Engine Lubricating Oil Purifier Feed Pump

- Maker: Taiko Kikai Industries
- No. of sets: 2
- Model: NHG-2.5MT
- Capacity: 2,300 litres/h at 2.5kg/cm2

Generator Engine Lubricating Oil Purifier

- Maker: Westfalia
- No. of sets: 1
- Model: OSD 6-91-067 design 4
- Capacity: 600 litres/h
- Motor: 4.6kW at 3,600 rpm
- Bowl speed: 12,000 rpm
- Control panel: Simatic C7-623/P

Generator Engine Lubricating Oil Purifier Feed Pump

- Maker: Taiko Kikai Industries
- No. of sets: 1
- Model: NHG-1MT
- Capacity: 600 litres/h at 2.5kg/cm2 and 1,200 rpm

Introduction

The purpose of the lubricating oil purifier is to remove water and solid particles from the lubricating oil to prevent damage being caused to the machinery the oil is supplying. There are two main engine LO purifiers which may be used for purifying the main engine sump tank, the LO drain tank, the LO settling tank, the stern tube LO tank and the generator engine LO systems. The generator engine LO purifier may be used for purifying LO from the generator engine sumps and the generator engine LO settling tank. Normally one of the main engine LO purifiers would be operating on the main engine LO sump with the other being cleaned or on standby. The generator engine LO purifier would be working on the operating generator engine sump or being cleaned.

Warning Note: Care must be taken when operating the purifier system. Hot oil and steam are present and can result in serious injury if leakage occurs.

There is a fire risk from the presence of hot oil and all precautions must be taken to prevent a fire and to deal with one should an outbreak occur.

The extinguishing system must be checked frequently.

Caution Note: Centrifuges operate on an automatic sludging system but failure of the system to effectively discharge sludge can cause overload and subsequent breakdown of the bowl arrangement which rotates at high speed. After manual cleaning, care is needed to ensure that the bowl is assembled correctly, as incorrect assembly can result in disintegration at high rotational speed. All operating and maintenance precautions stipulated by the manufacturer in the maintenance manual must be observed.

Purifier Operation

Liquid mixtures and solid/liquid mixtures can be separated by two methods; the gravity field of a settling tank or the centrifugal field of a purifier bowl. Both systems rely on the product components having different densities. Since the centrifugal field of a purifier is considerably more effective than the gravity field of a settling tank it is usual practice to favor the centrifugal field method.

The heated dirty oil enters the purifier and the centrifugal force created by the rotating bowl causes the liquid mixture to separate into its different constituents within the disc stack.

The solid particles suspended in the oil settle on the underside of the discs and slide down into the solid holding space. The smooth disc surfaces allow the solids to slide down and provide self-cleaning of the discs. Each bowl assembly is fitted with a regulating ring, sometimes referred to as a gravity disc. The diameter of the gravity disc is determined by the density of the oil to be purified and will determine the position of the interface between the oil and the sealing water. The position of this interface is critical for the effective separation of the liquid mixture.

Being of the self-cleaning type, the accumulation of solids within the holding space will be ejected at predetermined intervals depending on the quality of the oil. This is achieved automatically by the control panel and a number of solenoid valves which will bypass the oil supply and open the bowl for a set period of time by the use of high pressure water.

The C7-623 control unit is used for the automatic ejection control and condition monitoring of the oil purifier. The control unit has three modes of operation.

1- Partial ejections
2- Total ejections
3- Preselected partial ejections followed by total ejection

With the time dependant program cycle, it is important for high clarifying efficiency, to avoid desludging losses and that the separable solids content in the product do not fluctuate widely. The UNITROL system provides two basic monitoring systems.

1- Water content monitoring system (WMS)
2- Sludge space monitoring system (SMS)

The illuminated Liquid Crystal Display (LCD) provides information about the operating and malfunction condition of the purifier and displays all the relevant process data.

In addtion to the control cabinet the control system comprises all the complete line fittings incorporating electrical components which are controlled or monitored by the control unit which include:

- Dirty oil connection
- Water connection
- Operating water connection
- Circuit and water discharge valve
- Water sensor
- Thermometer for monitoring the dirty oil temperature
- A klaxon for sounding an audible alarm

Software assignment for a each purifier is carried out in the factory using a password function. Any alterations to the set parameters should only be carried out by a person authorised to make such changes.

The Lubricating Oil Purifier System

There are two centrifugal self-cleaning LO purifiers to be used for main engine duties and a separate purifier dedicated to the generator engines.

The main purifiers can be used for batch purification or for continuous purification and only one purifier would be used at any one time. Whilst the main engine is running a purifier is normally operating continuously drawing oil from the sump and returning it to the sump.

The generator engine sumps may be purified either during engine shutdown or whilst an engine is running. The generator engine LO purifier will normally be in use on the sump of a generator engine whilst it is running. The purifiers are supplied by feed pumps through steam heaters. There is a cross-connection which allows either main LO purifier supply pump to supply either main LO purifier. Instrument air is supplied to the purifiers to control the supply of oil to the bowl and the automatic discharge facility. Domestic (technical) fresh water is supplied for sealing and flushing purposes.

The purifiers take suction via the LO feed pumps and discharge to the following systems:

- Main LO settling tanks
- Main engine LO sump tank
- Stern tube LO drain tank

- Generator engine sumps
- Generator engine settling tank

Preparation for the Operation of the Purifying System

a- Transfer oil to the respective settling tank using the transfer pump or prepare to circulate the selected sump tank.

b- Check and record the level of oil in all LO tanks.

c- Open the self-closing test cock on the settling tank in use and then close it again when all water and sediment has drained.

d- All the valves in the purifier system should be closed.

e- Open the valves, as shown in the table below, depending on the system and purifier selected.

2.8.4 LUBRICATING OIL FILLING AND TRANSFER SYSTEM

Lubricating Oil Transfer Pump

- Maker: Taiko Kikai Industries
- No. of sets: 1
- Model: HNG-5MT
- Capacity: 5.0m3/h at 3.0kg/cm2 and 1,200 rpm

Introduction

Lubricating oil is stored in the following storage tanks, located in the engine room.

Tank Volume 100% (m3)

Main engine LO sump tank: 31.4

No.1 cylinder oil storage tank: 45.3

No.2 cylinder oil storage tank: 45.3

No.1 main engine LO storage tank: 22.5

No.2 main engine LO storage tank: 16.8

Main engine LO settling tank: 28.2

Generator engine LO storage tank: 15.0

Generator engine LO settling tank: 7.5

Turbine oil storage tank: 1.0

LO daily tanks, near generator engine 3rd deck: 2 x 0.25

LO daily tank (near air dryers 2nd deck): 0.5

LO daily tank (near AC plants 2nd deck): 0.1

Stern tube LO sump tank: 2.0

Outlet valves from most LO tanks are remote quick-closing valves with a collapsible bridge, which can be pneumatically operated from the fire control station. After being tripped, the valves must be reset locally. Each tank is fitted with a self-closing test cock to test for water and to drain any water present. Tundishes under the self-closing test cock drain any liquid to the bilge primary tank.

Lubricating oil is run down from the storage tanks to the main engine, generator diesel engines and other machinery services. The settling tanks are used to allow the contents of the sump of a generator engine, or the main engine, to be transferred prior to being centrifuged back to the sump, or centrifuged to the settling tank. Heating coils are fitted to the main and generator engine LO settling tanks. Oil from the cargo pump turbine sumps may be run down to the LO drain tank and purified if required but normally the oil charge in these turbine sumps is replaced.

All of the storage tanks are filled from connections on the port and starboard sides of the upper deck; the settling and renovating tanks may be filled from the same connections if required. Main LO tanks, generator engine LO tanks and cylinder oil tanks use separate connections to prevent cross contamination of grades.

The LO transfer pump has a capacity of 5.0m3/h at 3kg/cm2 and is used to transfer LO from one part of the ship to another. Its duties include batch transfer of LO from the main and generator engine sumps to the LO settling tanks prior to batch purification.

The pump can take suction from:

• Main engine sump

• Stern tube LO sump tank

• Generator engine sumps

• Generator engine LO settling tank

• Generator engine LO storage tank

• Main engine LO settling tank

• Main engine LO storage tank

The pump discharges to:

• Generator engine LO settling tank

• Generator engine sumps

• Stern tube LO drain tank

• Main engine LO settling tank

• The deck connections

CAUTION: Extreme care must be taken when transferring or purifying LO to ensure that main engine oil, generator diesel engine oil and turbine oil do not become mixed or contaminated. The setting of all valves must be checked prior to starting operations so that oil will only be

pumped or purified from the intended source and to the intended destination. All oil transfers must be record in the Oil Record Book.

2.9 Bilge System

2.9.1 Engine Room Bilge System and Bilge Separator

2.9 BILGE SYSTEM

2.9.1 ENGINE ROOM BILGE SYSTEM AND BILGE SEPARATOR

Engine Room Bilge Pump

- Maker: Taiko Kikai Industries
- No. of sets: 1
- Type: Horizontal gear pump
- Model: HNP-401
- Capacity: 5.0m3/h at 3.0kg/cm2
- Speed: 1,200 rpm

Sludge Pump

- Maker: Taiko Kikai Industries
- No. of sets: 1
- Type: Horizontal gear pump
- Model: HNP-401
- Capacity: 10m3/h at 4.0kg/cm2
- Speed: 1,200 rpm

Bilge, Fire and GS Pumps

- Maker: Teikoku Industries
- No. of sets: 2
- Model: 200-2VSR-AM-NV-S
- Type: Vertical centrifugal, self-priming
- Capacity: 230/180m3/h at 4.0/10kg/cm2
- Speed: 1,800 rpm

Bilge Separator

- Maker: RWO Water Technology
- No. of sets: 1
- Model: SKIT/S -DEB
- Capacity: 5.0m3/h

Introduction

The engine room bilge pump can take suction from:

• The engine room bilge wells

• The stern tube cooling water tank

• The bilge holding tank

• The main engine sunken part

• The main engine cofferdam recess

• The sanitary grey water tank

Apart from the bilge holding tank suction all of the bilge pump suctions are connected to the bilge main.

The engine room bilge pump discharges to:

• Bilge primary tank

• Shore connections on the port and starboard side, upper deck

• The waste oil service tank

The self-priming bilge fire and GS pumps can take suction from:

• Bilge suction main

• Sea water suction main

The self-priming bilge, fire and GS pumps can discharge to:

• Overboard

• The fire and deck wash main

• The IG scrubber SW cooling system

The No.2 main cooling sea water pump is provided with a 350mm diameter emergency bilge suction via valve BG019F. This takes its suction from the tank top and is operated locally from a handwheel fitted 460mm above the lower platform.

Note: The overboard discharge is not to be used for discharging bilges directly to sea unless under emergency conditions.

Caution Note: The intermediate shaft bearing which is located at frame 19.5 sits directly above the bilge holding tank, this tank is fitted with a high temperature alarm, tag No.1514 and is set at 45°C. It should be noted that excessive heating of this tank may result in the bilge holding tank structure distorting which could have serious consequences on the alignment of the intermediate bearing and shaft.

Primary Bilge Tank

The engine room oily drains from above the 4th deck level, the cascade filter tank and the purifier sludge tank all drain down to the 3.0m3 capacity primary bilge tank. Any other engine room waste drains to one of the three engine room bilge wells.

The primary bilge tank has two compartments and is designed to allow oily water to separate under the influence of gravity. The oil is drained from one side of the tank through the test/drain valves BG308F and BG309F where it passes to the separated bilge oil tank. The relatively clean oily water mix then passes into the second chamber of the tank from where it cascades to the bilge holding tank. A test/drain valve, BG310F, is located at the top of the final chamber and should be opened frequently after bilge pumping to test for the presence of oil and to drain any oil present on the surface of the water to the separated bilge oil tank. The tank can be drained of all its contents if necessary by opening valves BG313F and BG312F which connect to the much larger 52m3 bilge holding tank.

The Oily Bilge Separator

Caution Note: The oily water separator is designed to separate oil from water, not water from oil. Therefore, if the bilge water supply to the separator contains excessive amounts of oil it will render the equipment useless and result in unnecessary maintenance.

The oily water separator (OWS) conforms to the IMO resolution MEPEC.60(33) for oil content meters and oily water separating equipment in accordance with MARPOL 73/78, Annex I Regulation 16 and is fitted with an oil content meter alarm. The purpose of the separator is to separate the oil from the bilge water so that the oil residue in the treated water does not exceed 15ppm before being discharged overboard.

The separator consists of two units, the main section is a tank which contains an upper gravity section and a lower coalescent separation section. The second part of the unit is an emulsion breaking oil absorber section.

An eccentric helical rotor pump is located at the outlet of the separator and draws bilge water into the separator. As the oily water enters the OWS before it enters the pump, there is no emulsifying effect on the bilge water.

In the first section two separate stages of separation are used. During the first stage the extraction pump operates and draws the bilge water into the upper section of the separator. The larger droplets of oil naturally separate from the water by means of gravity and collect in the top region of the upper section. During the next phase of the operation, the oily water flows downwards through a coalescent of the open-porous type. Here fine separation takes place as the smaller particles of oil coalesce and form larger droplets that eventually break free and rise to the top of the upper section of the separator.

The cleaned bilge water is then drawn out of the lower section by the extraction pump where it then passes through the absorber unit. If at this stage the measured oil content is less than 14ppm the absorber unit is bypassed, this measure will help prolong the absorbers life span. If the measured oil content is 14ppm or above, the flow is directed through the absorber unit to ensure the discharge is maintained at a maximum level of 15ppm.

An oil level sensor is located in the oil collection region which detects when a quantity of oil is present. When the oil/water interface reaches the sensor a signal is sent to the control panel to activate the discharge mode. This signal opens the oil outlet valve and at the same time opens the fresh water back wash inlet valve. The oil collected in the top part of the upper section is discharged to the oily bilge tank via the oil outlet valve.

When the sensor has detected that the oil has been discharged the back wash process is initiated and the back wash water outlet valve opens, at the same time the oil outlet valve closes and the coalescer is back washed with clean water.

An oil content monitor (OCM) is situated on the discharge side of the separator extraction pump and continuously monitors the oil content of the bilge water discharge by the light scatter principle. If the oil content is greater than 15ppm the control system operates the three-way discharge valve and redirects the bilge water discharge to the bilge holding tank. When the OCM records an oil content of less than 15ppm the control system operates the three-way valve and directs the bilge water to overboard.

Procedure for Pumping the Bilge Holding Tank through the Oily Bilge Separator

The description assumes that the separator has already been commissioned and that it is filled with water. Valve BG325F is used for priming the separator for commissioning and after it has been drained for overhaul; the reclaimed oil will be discharged to the separated bilge oil tank.

a- Obtain permission to pump bilge water through the oily water separator from the duty navigating officer and the Chief Engineer Officer.
b- Obtain details from the bridge of the ship’s position and enter this in the Oil Record Book together with details of the bilge holding tank level and bilge well levels (when pumping bilge wells directly).
c- Check that the suction strainer is clean and clean if necessary.
d- Open the suction valve BG321F from the bilge holding tank and close the suction valve BG322F off the bilge main. Open the inlet valve to the oily water separator.
e- Check that the FW system is operating and able to supply the oily bilge separator and that valve WG041F is fully open.
f- Ensure power is available to the oily water and to the oil content meter.
g- Set the valves as in the following table:

Position	**Description**	**Valve**
Closed	Separator drain valves	
Operational	Solenoid controlled discharge valves	
Open	Separator overboard discharge valves	BG326F, BG327F
Closed	Return valve to bilge holding tank	BG328F
Open	Inlet valve to separator	BG324F

h- Ensure that all valves which are not required to be set for operation are closed.

i- Crack open the small discharge valve from the OWS to the oil analyzer.

j- Start the separator operating automatically by selecting AUTO operation and pressing the START pushbutton.

k- Switch on the oil monitoring unit and put it into AUTO mode.

Test the operation of the analyzer and ensure that the control system opens the valve to the bilge tank.

l- Open the upper vent cock and supply fresh water to the OWS; water should flow out of the test cock indicating that the OWS is filled with water. Close the test cock and shut the water filling valve.

m- The separator will run automatically, discharging oil to the separated bilge oil tank when the oil sensing probe detects an oil level. The oil content of the discharge water will be constantly monitored.

The control signal for the absorber bypass valve monitors the discharge value every 5 minutes, the absorber unit will be bypassed when the outlet valve is below 14ppm, above or equal to this value will direct the water through the absorber unit.

During the interrogation period, which takes approximately four seconds, the discharge is directed to the bilge holding tank because the sample unit which constantly monitors the total discharge is switched to the analyzing control circuit which controls the absorber bypass valve.

n- Stop the separator when the desired level is reached in the bilge holding tank. Switch off the oil content monitoring unit, shut off the separator and close all pump valves. When in automatic mode the separator induction pump will stop when the low level switch in the bilge holding tank is activated.

The clean exit water will be discharged overboard. Oil contamination of 15ppm or over will automatically be discharged back to the bilge holding tank until the water is clean enough to discharge overboard. Any oil collected at the top of the bilge separator will be discharged to the separated bilge oil tank.

The separator induction pump may also be used for pumping bilge wells directly. In this case the suction valve from the bilge main BG322F must be open and the suction valve from the bilge holding tank BG321F closed.

Individual bilge well suction valves must then be opened as required.

Pumping Bilges to the Bilge Primary Tank

The engine room bilge wells, stern tube cooling water tank, main engine pit and other spaces can be pumped to the bilge primary tank using the bilge pump. The pump can also be lined up to discharge to the shore connections.

Procedure for Pumping Bilges to the Bilge Holding Tank Using the Engine Room Bilge Pump

a) Clean all suction strainers.

b) Check that all instrumentation is working correctly.

c) Set the pump valves as in the following table:

The valve settings assume suction from the oily water tank. If other bilge spaces are to be pumped the appropriate valves must be opened.

Position Description Valve

Closed Bilge pump suction valve from bilge holding tank BG316F

Open Bilge pump suction valve from the bilge main BG317F

Closed Engine room bilge pump discharge valve to shore BG319F

Open Discharge valve to bilge primary tank BG320F

d) If a bilge well or another compartment is to be pumped out, the appropriate suction valve must be opened in addition to the bilge pump suction valve from the bilge main.

Bilge Main Suction Valves

Open Forward bilge well port BG010F

Open Forward bilge well starboard BG008F

Open Aft bilge well BG002F

Open Stern tube cooling water tank (normally locked closed) BG003F

Position Description Valve

Open Void space aft BG020F

Open Main engine sunken part BG006F

Open Cofferdam aft BG005F

Valves are shown as open but will only be open when pumping the particular bilge well or compartment.

e) Check the valve settings for the bilge pump discharge and for the desired tank suction.

f) Start the bilge pump and check that the correct bilge well is being emptied and that the bilge water is flowing to the bilge primary tank.

g) When the bilge well is empty, stop the bilge pump or select another bilge for emptying.

Operation of the Bilge Primary Tank

The primary bilge tank allows oily water to settle by means of gravity and sufficient time must be allowed for this settling to take place. Settling time depends upon temperature, the amount of oil in the water and the viscosity of the oil. The bilge primary tank has two compartments, the initial chamber into which the bilge water is pumped and the final chamber from where the cleaned water is discharged to the bilge holding tank.

In the initial chamber most of the settling takes place and oil rises to the top of the tank. Two test/drain valves BG308F and BG309F, allow the level of oil to be determined and oil to be drained to the separated bilge oil tank. The upper and lower valves should be operated and oil drained as necessary. Water flows from the bottom of the initial chamber into the final chamber where further separation takes place. A test/drain valve BG310F, is located at the top of the final chamber and this must be opened periodically in order to drain oil to the separated bilge oil tank.

Water overflows from the final chamber by means of a siphon pipe with its suction near the bottom of the chamber, the overflow water passes to the bilge holding tank. Depending upon the rate of bilge pumping and the initial oil content of the bilge water, the overflow water is relatively free from oil.

Water may drained from the primary bilge tank by means of valves BG312F and BG313F should it be necessary to drain the bilge primary tank for any reason.

Procedure for Pumping the Bilges to the Shore Connection using the Engine Room Bilge Pump

The procedure is the same as for pumping the bilges to the bilge primary tank except that the bilge holding tank may also be pumped to the shore connection, and a different discharge valve on the engine room bilge pump is used. The appropriate port or starboard shore connection valve must be open and the blank removed. The shore connection pipe must be attached to the pipe flange firmly and agreement reached with the reception facility about the pumping rate.

a) The bilge pump valves should be arranged as follows:

Position Description Valve

Open Bilge holding tank foot suction valve BG315F

Open/Closed Bilge pump suction valve from bilge holding tank BG316F

Open/Closed Bilge pump suction valve from the bilge main BG317F

Open Engine room bilge pump discharge valve to shore connection discharge line BG319F

Closed Engine room bilge pump discharge valve to the bilge primary tank BG320F

Bilge Main Suction Valves Position Description Valve

Open Forward bilge well port BG010F

Open Forward bilge well starboard BG008F

Open Aft bilge well BG002F

Open Stern tube cooling water tank

(normally fitted with blank spectacle plate) BG471F

Open Void space aft BG020F

Open Main engine sunken part BG006F

Open Cofferdam aft BG005F

b) When everything is connected correctly and the reception facility is ready to receive the bilge water, start the engine room bilge pump and pump out the selected bilge compartments using the valves as indicated.

c) Stop the bilge pump when the compartments to be pumped are dry. Close all system valves and return the blanks to the end of the shore connection pipes.

Procedure for Pumping Bilges using the Bilge, Fire and GS Pumps

These two pumps may be used for pumping the bilges and can be connected to the bilge main but are normally set for fire main duties.

Because they have the facility to be started remotely and may be needed in an emergency, it is important to normally leave the pumps set for fire duties.

a) Check that the bilge strainers are clear.

b) Determine which pump is to be used for pumping the bilges.

c) Set the bilge pump discharge valves as in the following table.

Unless stated all other valves must be closed. It is assumed that only one pump is being set to discharge the bilges, with the other pump still set for fire fighting duties.

Position Description Valve

Open No.1 bilge, fire and GS pump discharge valve to the overboard discharge line BG015F

Open No.1 bilge, fire and GS pump suction valve from bilge main BG012F

Close No.1 bilge, fire and GS pump sea suction valve FD001F

Close No.1 bilge, fire and GS pump discharge to fire main FD003F

Close No.2 bilge, fire and GS pump discharge valve to the overboard discharge line BG016F

Close Overboard discharge valve BG017F

Close No.2 bilge, fire and GS pump suction valve from bilge main BG013F

Open No.2 bilge, fire and GS pump sea suction valve FD002F

Open No.2 bilge, fire and GS pump discharge to fire main FD003F

Note: The fire main discharge valve is interlocked with the bilge suction valves on each bilge, fire and GS pump. The fire main discharge valve may not be opened when the bilge valve is open but a check must be made to ensure that the fire main discharge is closed whenever the bilge suction valve is opened.

d) Open the bilge suction valves, as required, in the following table:

Bilge Main Suction Valves

Position Description Valve

Open Forward bilge well port BG010F

Open Forward bilge well starboard BG008F

Open Aft bilge well BG002F

Open Stern tube cooling water tank (normally locked closed) BG471F

Open Void space aft BG020F

Open Main engine sunken part BG006F

Open Cofferdam aft BG005F

Note: No.1 bilge, fire and GS pump has a direct suction valve, BG014F, from the port forward bilge well.

e) Start the selected bilge, fire and GS pump and pump the contents of the selected bilge overboard.

Caution Note: Before any bilges are pumped directly overboard, it must be ensured that no local or international anti-pollution regulations will be contravened except where safety of the ship or personnel is involved.

Bilge Pumping to the Slop Tank

The bilge pump and the sludge pump may be used for pumping bilges and the contents of the separated bilge oil tank to the cargo slop tank are necessary.

The discharge valve from the pump to the shore connection line is to be open, BG319F for the bilge pump or BG306F for the sludge pump. The shore connection valves must be closed and blanks fitted on the shore connection outlets. The filling valve for the incinerator waste oil service tank OF357F must be closed.

A spool piece must be inserted in the discharge line to the slop tank between valves BG511F and BG512F and these valves must be opened. The discharge valve to the slop tank BG307F must be open and the bilge pump or sludge pump operated as required.

Emergency and Direct Bilge Suctions

No.1 bilge, fire and GS pump has a direct suction connection to the port forward bilge well via valve BG014F. An emergency bilge suction is provided at No.2 main cooling sea water pump via valve BG019F on that pump. Although these valves are not normally used it is essential that they are available for easy operation if necessary. The valve hand wheels should are operated, when practical, at least once each month to ensure that the valves will open freely when required.

It is essential that all bilge suction strainers are cleaned at frequent intervals to ensure that bilges can be pumped at all times. Should a strainer be blocked the pumping of that bilge will be impaired.

Steering Gear Room and Emergency Fire Pump Space Bilges

Bilges in the steering gear room and the emergency fire pump space are drained to the engine room after bilge well by means of self-closing drain valves located above the stern tube. Valve BG022F is used for draining the steering gear room bilges and valve BG021F is used for draining the emergency fire pump well.

The Separated Bilge Oil Tank

Contents of the separated bilge oil tank are normally pumped to the incinerator waste oil service tank using the sludge pump (see section 2.6.4 Incinerator Fuel Oil System). Lines to and from the sludge pump are trace heated and heating steam must be applied before operating the sludge pump. Suction valve BG301F and discharge valve BG306F are opened together with the discharge valve to the incinerator waste oil service tank OF357F.

Discharge of the Sanitary Grey Water Tank

In normal operations grey water is discharged overboard by means of gravity and an overboard discharge valve BS014F. Although with this ship trading in environmentally sensitive areas, grey water, where necessary according to local legislation, must be retained on board. Therefore a 20m3 grey water holding tank has been installed. A three-way valve BS017F is installed to either direct the water overboard or to the collection tank.

The contents of this grey water tank are discharge by the engine room bilge pump, either directly to shore facilities or to the primary bilge tank and thereafter via the OWS unit.

If necessary the OWS unit can draw directly from this tank via isolation valve BS022F which is normally kept locked.

If the grey water is to be discharged through the OWS it should be understood that any soap products in the water will tend to adhere to any traces of oil in the separator as it passes through. Therefore the separator should be thoroughly washed through before attempting to discharge this tank.

2.10 Air Systems

2.10.1 Starting Air System

2.10.2 General Service Air System

2.10.3 Control Air System

2.10 AIR SYSTEMS

2.10.1 STARTING AIR SYSTEM

Main Air Compressors

- Maker: Sperre
- Model: HV2/200
- No. of sets: 2
- Capacity: 165m3/h at 30kg/cm2
- Motor: 36kW, 440V, 60Hz
- Main Air Receivers
- No. of sets: 2
- Capacity: 5.5m3

Introduction

The starting air system is supplied by two main starting air compressors that supply two main air receivers. The compressors are set as ‘master’ and ‘follower’ on the UCS 2100 screen display ‘Compressors’. The compressors are designed to automatically start when the pressure in the starting air receiver falls to a preset value. The ‘master’ compressor cuts in at 25kg/cm2 and the ‘follower’ compressor at 23kg/cm2 on falling pressure. Both compressors stop at a pressure of 30kg/cm2. The No.2 compressor is fed from the emergency switchboard and has an electrically driven cooling water pump. The main air receivers supply the starting air for the main engine and the three diesel generator engines. The air is supplied to the three generator engines using a separate pipeline from that used for supplying the main engine. The control and service air systems can also be supplied from the starting air system through reducing valves should the control and service air compressors become inoperative. A double set of reducing valves is provided with a crossover valve, after the reducing valves, linking both systems.

The compressors are equipped with a high air temperature alarm and trip, the trip shuts down the machine when the set point is exceeded. A low LO temperature alarm and trip is also provided.

The 0.3m3 auxiliary air receiver is supplied from the main starting air receivers, or directly from the No.2 main air compressor in dead ship conditions, provided that the normally locked valve AS003F is opened. The compressed air in the auxiliary air reservoir is used to start the three generator engines when the main starting air reservoirs are isolated. Starting air is supplied to the generator engines via a reducing valve set to 10kg/cm2 at the generator engine starting air lines.

Each compressor has an automatic unloader on the first and second stage valves. It opens the discharge valves just before the compressor stops and closes shortly after the compressor runs up to speed, this allows the compressor to start and stop off load. The compressors are started and stopped by pressure switches situated on the gauge manifold air line between the main reservoirs.

The generator engine starting air supply valves on the main air reservoirs are normally open to ensure that the standby generator engines can be started at any time.

The main air compressors are water cooled and are supplied by the central cooling fresh water system.

Switches at the starter panel in the main switchboard room enable the compressors to be manually started and stopped. When in remote operation, they can be arranged for automatic operation from the UCS 2100 control and monitoring display.

Procedure for Operating the Starting Air System

a) Ensure that all pressure gauge and instrumentation valves are open.
b) Check the oil level in the compressors and check also for the presence of water.
c) Ensure that the central fresh water cooling system valves are open. A solenoid valve on the cooling water inlet to the compressor will open when the machine receives a start signal.
d) Only one reservoir should be in use during normal operations at sea as this will maintain a reserve should a pressure loss occur in the system.
e) Set up the valves as shown in the table below. The valves are shown as set for the given compressor and air reservoir combination.

Assuming both starting air compressors are available, with both the main starting air reservoirs and the auxiliary air reservoir open for filling:

Position Description Valve

Open No.1 compressor discharge valve AS001F
Open No.2 compressor discharge valve AS002F
Open No.1 reservoir inlet valve
Open No.1 reservoir outlet valve to generator engine and general service

Position Description Valve

Open No.1 reservoir outlet valve to main engine starting air
Open No.1 reservoir outlet valve to gauge manifold
Open No.1 reservoir drain trap inlet valve
Closed No.1 reservoir drain trap bypass valve
Open No.2 reservoir inlet valve
Open No.2 reservoir outlet valve to generator engine and general service
Open No.2 reservoir outlet valve to main engine starting air
Open No.2 reservoir outlet valve to gauge manifold
Open No.2 reservoir drain trap inlet valve
Closed No.2 reservoir drain trap bypass valve

Open Generator engine starting air supply valve AS004F
Open Generator engine No.1 reducing valve inlet valve AS011F
Open Generator engine No.1 reducing valve outlet valve AS013F
Open Generator engine No.2 reducing valve inlet valve AS012F
Open Generator engine No.2 reducing valve outlet valve AS014F
Open Generator air line drain trap valve AS008F
Closed Generator air line direct drain valve AS010F
Open No.1 generator engine supply valve AS471F
Open No.2 generator engine supply valve AS472F
Open No.3 generator engine supply valve AS473F
Open Generator air reservoir filling/outlet valve

Automatic Operation

For automatic operation of the start air compressors:

a) Ensure power is available to the main air compressor starter panels. Set the mode switch to REMOTE on each compressors respective group starter panel on the main switchboard.

b) On the UCS 2100 ‘compressor’ screen display, select the ‘master’ ‘follower’ configuration. When a start signal is received, the lead compressor will run off-load for approximately 15-20 seconds after which time the drain/unloading solenoid valves will be energized to close and allow the discharge of compressed air to the system.

2.10.2 GENERAL SERVICE AIR SYSTEM

General Service Air Compressor

- Maker: J.P. Sauer and Sohn
- Model: SCK 26-10-MA60
- Type: Screw type, air cooled
- No. of sets: 1
- Capacity: 150m3/h at 7.0kg/cm2

Air Drier

- Maker Dominick Hunter Ltd
- Type: Desiccant
- Model: DME060
- No. of sets: 1
- Capacity: 100Nm3/h

Introduction

The General Service (GS) air system is supplied by one electric motor driven air compressor operating at a pressure of 7.0kg/cm2 (the compressor cut-out pressure is set at 7.9 bar. The compressor discharges to a 1.5m3 air receiver and is controlled by the pressure in the receiver with the machine loading and unloading as required.

The compressor is fitted inside an acoustic hood that is equipped with a local control panel. This provides a digital read out of the system pressure, the air temperature at the compressor outlet and the operating status of the machine. It is menu driven and can be used to obtain operating information or details on alarms and shutdowns. Pressing the INFO button will display the system information. Pressing this button up to twelve times will display, at each press, information on the compressor's operating parameters and set points. A set point can be adjusted by bringing up the correct line item, using the up/down buttons to increase/decrease the setting and then pressing ENTER. The set points can only be altered when the machine has been stopped and the stop 'O' button pressed for a further 3 seconds.

The GS air system is ordinarily supplied by the GS air compressor and the GS air receiver, however in the event of a failure of this compressor, air may be supplied from the main starting air system through a reducing valve. The supply valve to the reducing station is locked open.

With the vessel classified for cold climate conditions, it is therefore important that the dryer unit is in operation when supplying working air to deck in order to ensure that there is no possibility of any wet air being used on deck which could possibly freeze in control equipment or on valve seats etc.

The GS air system is used to supply the following services:

- Generator engine emergency DO pump
- Air conditioning room
- Accommodation services
- Deck services via a desiccant dryer, including the mast air horn, overfill alarm horn and ballast tank bubbling air
- Foam room
- IG generator and fan room
- Engine room service air system
- Purifier room
- Incinerator atomising air
- Boiler atomising air
- Local fire fighting pump unit
- Main engine jacket FW transfer pump
- Flue gas take-up valve cleaning
- Workshop
- Economiser sootblowers
- Emergency generator engine room
- The steering gear room
- Main engine turbocharger cleaning
- Main engine jacket fresh water transfer pump
- Auxiliary boiler service
- Fuel valve test rig

Procedure for Preparing the GS Air System for Operation

The GS air compressor is started by pressing the 'I' button on the local control panel. The compressor will automatically start and load itself unless the line pressure is above the pressure cut-in set point or the start temperature is below 5°C. The green running light will illuminate with a steady light unless the machine is inhibited as stated above in which case the green light will flash.

Warning Note: A flashing green light means the compressor is on standby and can start

up automatically without any warning.

Using the menu driven control panel, the compressor can be set to AUTOMATIC mode. This will ensure the compressor will automatically restart after power failure and is activated by having the 'restart' mode set to 1. Setting to 0 will switch the automatic restart off.

2.10.3 CONTROL AIR SYSTEM

Control Air Compressor

- Maker: J.P. Sauer and Sohn
- Model: SCK 26-10-MA60
- Type: Screw type, air cooled
- No. of sets: 1
- Capacity: 150m3/h at 7.0kg/cm2

Air Drier

- Maker Dominick Hunter Ltd
- Type: Desiccant
- Model: DME060
- No. of sets: 2
- Capacity: 100m3/h

Introduction

The control air system is supplied by one electric motor driven air compressor operating at a pressure of 7.0kg/cm2 (cut-out set at 7.9 bar). The compressor is the same make and model as the GS air compressor and so the operating instructions for this machine are identical but some details have been repeated for completeness.

As with the GS air compressor the control air compressor is fitted inside an acoustic hood that is equipped with a local control panel. This provides a digital read out of the system pressure, the air temperature at the compressor outlet and the operating status of the machine. It is menu driven and can be used to obtain operating information or details on alarms and shutdowns.

Pressing the INFO button will display system information. Pressing this button up to twelve times will display, at each press, information on the compressor's operating parameters and set points. A set point can be adjusted by bringing up the correct line item, using the up/down buttons to increase/decrease the setting and then pressing ENTER. The set points can only be altered however when the machine has been stopped and the stop 'O' button pressed for a further 3 seconds.

The compressor discharges to a 1.5m3 air receiver and is controlled by the pressure in the receiver. In an emergency the system can be supplied with air from the main starting air system via a pressure reducing valve. The control air is processed through one of two control air dryers and associated filters before entering the control air pipework system. The dryers are of the activated alumina type which contain chemicals that act as a desiccant to absorb moisture from the air. There are two dryers installed and they supply all of the engine room control systems. Normally one dryer will be in service with the other on standby or undergoing maintenance.

The drying process is automatic and the desiccant is purged of water whilst the unit is in operation. Each dryer has two towers containing desiccant with one tower in service while the other is purging. Purging is achieved by passing some of the already dried control air over the desiccant in the tower being purged. The operation to change between towers is automatic and the desiccant material has an operating life in excess of 5 years.

The control air is supplied to a main line to which a number of manifolds are fitted. Direct control air supplies are taken from a number of locations but most users are supplied from manifolds which have isolating valves and a drain valve fitted. The drain valve is normally closed but should be opened periodically to drain any water which might build up.

Note: It is essential that the control air is dried before entering the system as any moisture can cause problems in actuators or other parts which could lead to failure. The air dryers are fitted with a bypass valve which is locked closed. Only in the event of failure of the control air dryer system should the dryer bypass valve be opened.

The following services are supplied by the control air system:

- Alarm air horns
- Inert gas control air
- Remote sounding system
- Main engine safety air system
- Main engine control air system
- Main engine automatic backflushing LO filters
- Main engine automatic backflushing FO filters
- Generator engine control systems
- Boiler control systems
- Purifier control systems
- Auxiliary systems pressure and temperature controllers

Procedure for Preparing the Control Air System for Operation

The control air compressor is started by pressing the 'I' button on the local control panel. The compressor will automatically start and load itself unless the line pressure is above the pressure cut-in set point or the start temperature is below 5°C. The green running light will illuminate with a steady light unless the machine is inhibited as stated above, in which case the green light will flash.

2.11 STEERING GEAR

2.11.1 STEERING GEAR

- Maker: Samsung-Hatlapa
- Type: A4VG model R4ST 650
- System pressure: 142 bar
- Tiller type: Solid with a key
- Rudder angle: 35° normal operation
- Header tank capacity: 350 litres

Introduction

The steering gear consists of four hydraulic rams driven by two electrically driven pumps. The pumps are of the variable displacement axial piston type of swashplate design for closed circuit transmissions. The steering gear is capable of operating as two totally isolated steering systems with each pump capable of putting the rudder through the working angle in the specified time.

The second pump or standby unit can be connected at any time by starting the motor.

The steering gear is provided with an automatic isolation system. Both hydraulic systems are interconnected by means of solenoid operated isolating valves that, in normal operation, allow both systems to produce the torque necessary for moving the rudder. In the event of a failure that causes a loss of hydraulic fluid from one of the systems, the float switches in the expansion tank are actuated. This gives a signal to the isolation system, which automatically divides the steering gear into two individual systems. The defective system is isolated, whilst the intact system remains fully operational so that steering capability is maintained with 50% of the rudder torque. The steering gear is remotely controlled by the autopilot control or by hand steering from the wheelhouse. Emergency control is carried out by the operation of the local pushbuttons on the solenoid valves on the autopilot units.

All orders from the bridge to the steering compartment are transmitted electrically and steering gear feedback transmitters supply the actual steering gear position. No.2 pump unit is supplied with electrical power from the emergency switchboard and No.1 pump unit from the main switchboard.

The rudder angle is limited to 35° port and 35° starboard by electrical limit switches but under extreme loads can go to 37° in both directions where mechanical stops will prevent the rudder from turning any further. The variable flow pumps are operated by a control lever, which activates the tilting lever of the pump’s swashplate, which causes pressurised oil to be discharged to the hydraulic cylinders. When the tiller reaches the required angle, the tilting lever is restored to the neutral position, which causes the pump to stop discharging.

2.12 Electrical Power Generators

2.12.1 Diesel Generators

2.12.2 Emergency Diesel Generator

2.12 ELECTRICAL POWER GENERATORS

2.12.1 DIESEL GENERATORS

Diesel Engine

- Maker: STX-MAN-B&W
- No. of sets: 3
- Type: 6L23/30H
- No. of cylinders: 6
- Bore: 225mm
- Stroke: 300mm
- Speed: 900 rpm
- Rating: 960kW
- Piston speed: 9.0m/s
- Mean effective pressure: 17.9 bar
- Maximum cylinder pressure: 130 bar
- Rotation: Clockwise viewing from flywheel end

Turbocharger

- Maker: ENPACO-MAN-B&W
- Type: NR 20/R

Governor

- Maker: Woodward
- Type: UG-8

Alternator

- Maker: Hyundai Heavy Industries
- Type: HF J6 564-84K-SB
- Capacity: 1,137.50 kVA
- Rating: Continuous
- Voltage: 450V, 3 phase
- Frequency: 60Hz
- Speed: 900 rpm

Introduction

Three diesel generators operate in the medium speed range and supply electrical power for the ship. Each has a generating capacity of 910kW.

The engines have six cylinders and are turbocharged, uni-directional, four stroke, trunk in-line engines which are normally operated on heavy fuel oil. They can also be supplied with diesel oil, which is used for flushing through, prior to shutting down for prolonged periods or for maintenance.

One diesel generator is used during normal sea going conditions but two generators are required during manoeuvring.

Starting Air System

The engines are started by an air driven starter motor that operates off the starting air system at a reduced pressure of 10kg/cm2. When the start valve is opened by the remote controlled solenoid, air is supplied to the air start motor. The air supply activates a piston, causing the pinion to engage with the gear rim on the flywheel. When the pinion is fully engaged pilot air opens the main air valve, which supplies air to the air starter motor, causing the engine to turn.

When the revolutions exceed about 158 rpm, if conditions are normal and firing has taken place, the start valve is closed and the pinion piston and main air valve are vented. A return spring disengages the pinion from the flywheel and the air motor stops. An on-line air lubricator is fitted to lubricate the start air motor.

During starting a pneumatic cylinder operates a stop arm to limit the fuel regulating shaft.

The engines can also be started locally from the local control panel. Press the LOCAL pushbutton and press the START pushbutton. Additionally, there is an emergency starting pushbutton located on the starting valve. The engine is switched to LOCAL at the local control panel, the emergency start button is pressed with a screwdriver or similar implement until the engine fires and then the emergency start button is released.

2.12.2 EMERGENCY DIESEL GENERATOR

Diesel Engine

- Maker: Cummins
- Type: 4 stroke, 6 cylinder turbocharged diesel engine
- Model: KTA19
- No. of sets: 1
- Output: 500kW
- Speed: 1,800 rpm
- Rating: Continuous
- Displacement: 18.9 litre
- Compression ratio: 13.9 : 1

Generator

- Maker: Leroy Somer
- Model: LSAM47.1 L10
- Type: Horizontal self-exciting brushless
- Capacity: 437.5kVA
- Voltage: 450V, 3 phase
- Frequency: 60Hz
- Speed: 1,800 rpm

Generating Set

- Maker: STX Corporation, Korea

Introduction

The emergency diesel generator is a self-contained diesel engine located in the emergency generator room sited in the starboard side of the engine casing on A deck.

The generator set will start automatically on power failure from the main diesel generators and connect to the emergency switchboard to maintain supplies to essential services. It will also be used to get the ship under power from dead ship condition and will enable power to be supplied to essential services selectively without the need for external services such as starting air, fuel oil supply and cooling water. Additionally, it can be selected to start automatically on the initiation of a fire alarm, the mode selection switch is on the main fire alarm detection panel in the foam room fire control station.

The engine is an in-line 6 cylinder turbocharged engine, 159mm bore by 159mm stroke, with a self-contained cooling water system. The cooling water is radiator cooled, and circulated by an engine driven pump. A thermostat maintains a water outlet temperature of 82-93°C; the alarm point is 102°C and the trip 106°C. Air is drawn across the radiator by an engine driven fan.

The cooling water is circulated by an engine driven pump, which also supplies cooling water to the LO cooler. An electric heater is fitted to keep the cooling water at 40°C to 45°C when the engine is on automatic standby. After leaving the engine the cooling water flows through the turbocharger after cooler before passing to the thermostat and radiator. In cold conditions ethylene glycol antifreeze should be added to the cooling water system.

PART 3: OIL SPILL AND POLLUTION PREVENTION - CARGO

Introduction

Small spills can occur during routine transfer operations on the ship, i.e. during loading, discharging, ballasting, bunkering etc. If an oil spill occurs at any time, the Shipboard Oil Spill Response Plan (SOSRP) must immediately be put into operation.

Responsibilities

The responsibilities of shipboard officers are clearly laid down in the company's regulations but may be summarized as follows.

During any loading, transferring or discharging of cargo, tank cleaning or ballasting and when bunkering, the Master or chief officer and the Chief Engineer or second engineer must be on board.

During these operations at least one deck officer and engineer must be on duty.

Preventative Measures

The prevention of oil spills must be regarded as a high priority in any oil transfer operation. The most commonly recorded causes of operational spills are cargo and bunker overflows, pipeline leakage including COW lines, leakage from overboard and sea valves, the accidental discharge of dirty ballast and lastly oil spray from tank vents and common vapor risers. In addition, direct leakage from the ship's hull is an occasional cause of minor spillages. Measures adopted to prevent these occurrences are fully described in the International Safety Guide for Oil Tankers and Terminals (ISGOTT), and include specific items on the Ship/Shore Safety Checklist. A copy of this publication should be kept with this plan.

If, despite the adherence to proper procedures, an oil spill does occur, all cargo and bunker operations should be stopped by the quickest possible means and should not be restarted until the source of the leak has been identified, rectified and all hazards from the oil released have been eliminated. In most cases, the cause of the leak will be obvious but, in some instances, such as spillages resulting from slight hull leakage, the source may be difficult to locate, requiring the services of a diver.

The duty officer assisted by the duty watchman should undertake the following actions in the event of an incident. He should also inform the Master, chief officer and the Chief Engineer to facilitate the mobilization of additional manpower as required and to initiate notification procedures.

Tank Overflow

Should a tank overflow occur, the flow to the tank should be stopped immediately and the level in the tank lowered by the most practical means.

Pipeline Leakage

Should leakage occur from the ship's on-deck pipe work or from transfer hoses, the cargo operation should be stopped immediately and pressure relieved from the leaking section of line. The line content may be dropped or, if necessary, pumped into an empty or slack tank.

Overboard and Sea Valves Leakage

Should leakage from an overboard or sea valve occur, the cargo operation should be stopped immediately and the pressure relieved from the relevant sections of line.

Oil Spray from Tank Vents and Common Vapor Risers

Should an oil spray occur from tank vents/mast risers, the cargo flow should be stopped and the vent/riser shut and allowed to drain. The cause of the oil entrainment in the vapor flow should be established and the necessary measures taken to prevent recurrence.

Hull Leakage

Should spillage be suspected due to hull leakage, measures should be taken to reduce the head of cargo in the tank involved, either by internal transfer, listing/trimming the ship or discharge ashore. Unless timely corrective action is taken, oil will continue to leak to the sea until a hydrostatic balance is achieved between the head of oil remaining in the tank and the sea water pressure exerted on the hull. Should it not be possible to identify the specific tank from which leakage is occurring, the levels of all tanks in the vicinity should be reduced, taking into account the effect on hull stress and stability.

Should it be suspected that leakage is from a fracture in the bottom plating or lower shell plating, consideration should be given to reducing the level in the tank, if full, and then pumping a water bottom into the damaged tank to prevent any further oil spillage.

Containment on Board

In the event of an oil spill on deck, the following steps should be taken to prevent or minimize over side pollution utilizing the on board spill equipment.

a) Identify the source and stop the leak.
b) Place drip trays or containers to catch the leakage.
c) Bail or pump pools of oil into tanks, drip trays or containers.
d) Soak up the oil with absorbent material form the SOSRP kit.
e) Ensure scupper plugs are tight and any excess water is drained off.
f) List/trim the ship to maintain/increase the deck scupper volume.

The prevention of over side pollution and its mitigation takes precedence over cargo quality and contamination concerns.

Oil Leakage/Overflow During Loading

a) Contact the terminal and request to stop loading immediately.
Cease all cargo and ballast operations.

b) Follow the individual terminal emergency stop procedures and signals.

c) Manifold valves may be closed only after permission is received from the terminal.

d) In case of overflow, open valves to any empty/slack tanks to reduce the level of the overflowing tank.

e) Sound the General Emergency Alarm with a PA broadcast and muster the oil spill emergency response team.

f) Check/stop the air intake to accommodation, stop non-essential air intakes to the engine room.

g) Close all non-essential sea suctions.

h) Re-check that all scuppers are shut.

i) Contain the spill on board by opening the main deck drain valve leading directly to either the port or starboard slop tank, or by using the fixed Wilden pump at the pump room entrance which discharges into the port slop tank.

j) Deck clean up is to be started and fire fighting equipment to be kept ready for use.

k) Oil spill dispersants/emulsifiers should never be used overside except for small spills where written approval is received from the appropriate authorities.

l) Reporting procedures to be followed as per the SOSRP/VRP depending on the location of the ship.

m) Loading may be resumed after the fault has been rectified.

PART 4- EMERGENCY SYSTEMS

4.1 Engine Room Fire Hydrant System

4.2 Engine Room Hot Foam Fire Extinguishing System

4.3 Engine Room Local Fire Fighting System

4.4 Quick-Closing Valves, Fire Dampers and Emergency Stops

4.5 CO2 System

4.1 ENGINE ROOM FIRE HYDRANT SYSTEM

Bilge, Fire and GS Pump

- Maker: Teikoku Machinery Works Ltd
- No. of sets: 2
- Type: Vertical centrifugal
- Model: 200-2VSR-AM-NV-S
- Capacity: 230/180m3/h at 4.0/10kg/cm2
- Speed: 1,800 rpm

Fire Line Pressurising Pump

- Maker: Teikoku Machinery Works Ltd
- Type: 100SXUM
- No. of sets: 1
- Capacity: 25m3/h at 9.0kg/cm2
- Speed: 3,600 rpm

Emergency Fire Pump

- Maker: Teikoku Machinery Works Ltd
- Type: 250-2VSR-BM-NV-S
- No. of sets: 1
- Capacity: 450m3/h at 90mth
- Speed: 1,800 rpm

Introduction

The fire and deck wash system can supply sea water to the following systems:

- The fire hydrants in the engine room
- The fire hydrants on deck
- The hawse pipe wash
- The hot foam system for the engine and pump room
- The economiser water washing system
- The soot drain tank
- The inert gas scrubber cooling salt water crossover line
- The bosun's store bilge and chain locker bilge eductor
- The deck foam system

The bilge, fire and GS pumps connect onto the fire main system and are normally kept ready on the fire main so that in the case of an emergency they are immediately available and can be remotely started from the fire control room, in the CECR on the engine room console or the bridge. The pumps take suction from the sea via the engine room crossover main which has connections to the high and low sea chests or from the bilge system. The pump suction valves from this sea suction main and the discharge valves to the fire main outlet, are normally left open. The bilge suction valves on the bilge, fire and general service pumps are interlocked, this prevents either of the bilge suction valves from being opened at the same time as the discharge valve to the fire main is open.

The fire line pressurising pump takes suction only from the sea water crossover main and discharges to the fire main. The pump when set to Automatic maintains a pressure in the fire

main so that an immediate fire fighting capability is provided, but because of its low capacity, if more than one hydrant is opened, a bilge, fire and GS pump will be automatically started (depending which pump has its isolation breaker in). Additionally, if necessary the more powerful emergency fire pump can be started either locally or from one of the remote operation positions.
The emergency fire pump pipework is configured to supply the fire main and hot foam system. It is an electrically driven self-priming centrifugal pump and is situated in the emergency fire pump recess in the steering gear room. Its power supply is taken from the emergency switchboard and it can be started remotely from the bridge or from the fire control room. The emergency fire pump has its own sea suction chest with the suction valve FD556F, being remotely operated from a hydraulic handwheel FD587F in the steering gear room. The emergency fire pump sea suction valve is locked in the open position.

An air loaded accumulator cylinder connected to the fire main in the engine room dampens out pressure fluctuations in the fire main system and allows the pressurising pump to be on standby but not running. Pressure switches are used to start and stop the pressurising pump and air is supplied to the accumulator from the service air system by means of air valve AR029F. The accumulator relief valve lifts at a pressure of 12kg/cm2.

Emergency Fire Pump
If the emergency fire pump is to be used this can be started remotely either from the bridge or fire control station. Additionally, the pump will start automatically when the hot foam system for the engine room or pump room is activated. The suction valve FD556F and the discharge valve to the fire main FD583F from this pump are always kept open so the pump can be started and can supply water to the fire main and hot foam system immediately. The valves should, however, be operated periodically to ensure that they are operational and free to be closed should the need arise.

The Fire Main
The fire main has outlets in the engine room, around the accommodation block and on the deck forward and aft. At each hydrant outlet is a hose box containing a fire hose and nozzle unit. The hydrant outlet valves should be operated at frequent intervals to ensure that they will open satisfactorily should it be necessary in the event of an emergency.
Intermediate valves in the fire main along the deck should be kept open at all times to ensure that water will be available at all deck hydrants whenever required.
In addition to supplying water to fire hydrants the fire main system also supplies water to the hot foam system (high expansion foam system) for the engine and pump room and the foam system for the deck.
The bilge eductors in the bosun's store are operated by water supplied from the fire main.
The fire main must be maintained in an operational condition at all times and all hydrant valves must be closed so that pressure is available at the hydrants as required. The foam systems are an essential part of the ship's fire fighting capability and the valves to these units must be free and easily operated.

When the ship is trading is cold climate areas with the risk of freezing on deck, it will be necessary for the deck fire main to be isolated from the engine room riser and the feed line from the emergency fire pump. It will be necessary for the hydrant lines on deck and around the accommodation to be fully drained down with the drain valves left in the open condition.

Accommodation First Aid Fresh Water Hose Reels
A fresh water first aid fire hose reel, 25mm diameter by 20m is located on each deck in the accommodation located adjacent to the central stair well. These hose reels allow a first strike capability in the accommodation in the event of the deck fire main being drained down due to freezing climate operational conditions until the deck fire hydrant system is brought back into service.

4.2 ENGINE ROOM HOT FOAM FIRE EXTINGUISHING SYSTEM

Foam System

- Maker: Unitor
- No. of sets: 1
- Tank capacity: 3.0m3

Foam Pump

- No. of sets: 1
- Type: Vertical centrifugal
- Model: DPVF 4 - 80
- Capacity: 4.3m3/h

Introduction
The Unitor Hot Foam fire fighting system is a high expansion foam system that provides a fire extinguishing capability to the following areas:

- Engine room
- Main switchboard room
- Incinerator room
- Electrical workshop
- Purifier room
- Engine room casing
- Pump room

The system supplies foam to outlets at various points in the machinery spaces, there being four main supply lines each with its own remotely operated butterfly valve. Foam generators are fitted at designated points in the foam supply lines and these produce the foam and direct it into the protected spaces. Foam is produced by mixing sea water, supplied from the emergency fire pump or one of the two bilge, fire and GS pumps with a foam making chemical.

The emergency fire pump would ordinarily be used to operate the hot foam facility but in the event of a problem with this pump or a fire in this area, the bilge, fire and GS pumps could be used. Foam is generated by mixing the foam making chemical with sea water at a rate of 2% chemical solution to 98% sea water. The foam making chemical is stored in a 3.0m3 tank of steel construction located in the foam room and fire control station and is supplied to the two foam proportioners by the foam pump. In the proportioners, the foam chemical mixes with sea water and the combined sea water and liquid foam mix is pumped to the protected spaces through 125mm supply lines. There are two foam proportioners, one for the starboard side of the engine room and pump room and one for the port side of the engine room and pump room. The pump room is provided with hot foam generators designed to produce the required quantity and concentration of foam to meet SOLAS requirements. There are ten foam generators, type HG-25 which have a foam production capability of 60m3/min covering the pump room area. The HG-25 generators are designed as an integral part of the hot foam system in which air from the protected space is used to aid foam production even when smoke and combustion gases are present. The generators are constructed from stainless steel and are built as one unit without any moving parts. The HG-25 generators consist of three nozzles. The nozzles send a water/foam mix into the generator housings and with the speed at which it passes through the housing it creates a negative pressure. This pressure reduction causes air/smoke to be drawn in to the housing so mixing with the foam/water and creating a high expansion foam.

To ensure correct system operation, only the foam making chemical supplied by the system manufacturer should be used in this installation.
Electrical power for the system is supplied from the main switchboard with back-up being supplied from the emergency switchboard.

4.3 ENGINE ROOM LOCAL FIRE FIGHTING SYSTEM

Fire Fighting Equipment

- Maker: Novenco Hi-Press
- Type: CR5-18
- Capacity: 7m3/h at 3,500 rpm
- Pressure: 11.33 bar
- No. of sets: 1
- Nozzle type: NHP5

Introduction

The Novenco Hi-Press fire fighting system provides a high pressure water mist spray to specific areas of the machinery space and is additional to and independent of the engine room hot foam fire fighting system.

The principle of the water mist system is that the very fine droplets of water tend to exclude oxygen from the atmosphere in the vicinity of the fire thereby starving the burning material of oxygen. When the fine water droplets come into contact with the flames they rapidly evaporate because of their large surface area for small mass and this produces a rapid cooling effect on the fire. The steam produced by the evaporation acts to further reduce the space available for oxygen. Because the water is in mist form the system is also useful for oil fires.

Water at high pressure is injected into the protected space through special nozzles which break down the water stream into very fine mist like particles.

The positioning and distance of the spray heads from the protected equipment is critical to ensure complete protection is provided.

The equipment consists of a high pressure pump which takes suction from the operating fresh water tank supplying the ship's domestic water system.

One of the tank's outlet valves will always be open and the second may be opened as required but the system is based on high pressure rather than high volume. The pump is located in the engine room on the 2nd deck starboard aft near the control air dryers.

The pump supplies seven outlet lines fitted with a total of 37 sprinkler nozzles which serve various areas of the machinery space. Each outlet has its own supply valve remotely operated from the control panel.

The areas protected by the Hi-Press system are as listed below:

Loop 1, Main engine: 8 heads
Loop 2, Generator engines: 8 heads
Loop 3, Purifier room: 8 heads
Loop 4, Incinerator room: 2 heads
Loop 6, Steering gear room: 5 heads
Loop 5, Auxiliary boilers: 4 heads
Loop 7, Inert gas generator room: 2 heads

The system is maintained in a constant state of readiness and the pump is permanently connected to a fresh water supply.

4.4 QUICK-CLOSING VALVES, FIRE DAMPERS AND EMERGENCY STOPS

Introduction

All of the outlet valves from the fuel oil and lubricating oil tanks from which oil could flow to feed a fire are equipped with pneumatically operated quickclosing valves. These valves are operated from the fire control station located on the upper deck in the port forward area of the accommodation block.

The valves are supplied with compressed air at 7kg/cm2 from a 100 litre storage bottle located in the fire control station. The bottle is fitted with an alarm to warn of low pressure and is fed directly from the engine room service air main. A non-return valve is fitted on the inlet line which is normally left open to ensure that a full charge of air is always available In addition to the main tank valve system, the inlet fuel oil supply line to the main engine and each diesel generator engine is fitted with a quick-closing valve. These valves operate in the same way as the quick-closing tank valves but they are operated from a separate cabinet located near the main starting air receivers. Air for actuation of these fuel supply quick-closing valves comes from the control air ring main via a valve located at the bulkhead aft of the generator engines.

In normal operation the supply line to each group of tank valves is vented to atmosphere, but when the cock is turned, compressed air is directed to the pistons, which collapse the bridge of each valve in that group, thus causing the valve to close.

The valves are reset by venting the air supply and operating the valve handwheel in a closed direction to reset the bridge mechanism and then opening the valve in the normal way.

The exceptions to the above operating system are the MDO tanks for the emergency generator, the incinerator and the waste oil tank. All of these are operated locally from just outside the spaces by cable pull wires.

The main sea suction valves are operated remotely by hydraulic systems from handwheels located on the 2nd deck level in the engine room but outside of the main switchboard room.

4.5 CO_2 SYSTEM

System Equipment

- Maker: NK Co. Ltd
- Type: High pressure
- Capacity: 9 cylinders each containing 45kg CO_2

Introduction

Depending upon the application, CO_2 is normally employed at levels of between 35% and 50% by volume to produce an oxygen deficiency and thus extinguish a fire. This level of oxygen reduction is also capable of causing asphyxiation. Fixed systems are therefore designed to include safeguards which prevent the automatic release of the CO_2 whilst the protected area is occupied. The users of portable extinguishers should ensure that there is sufficient air to breathe normally.

CO_2 is not generally regarded as having a high intrinsic toxicity and is not normally considered to produce decomposite products in a fire situation. The CO_2 cylinders are fitted with safety devices to relieve excess pressure caused by high temperatures. To avoid these operating, it is recommended that cylinders are located in areas where the ambient temperature will not exceed 46°C. Cylinders must not be stored in direct sunlight.

Certain gaseous extinguishing agents may cause low temperature burns when in contact with the skin. In such cases the affected area should be thoroughly irrigated with clean water and afterwards dressed by a trained person.

WARNING Note: DANGER OF ASPHYXIATION Re-entry to a CO_2 flooded area should not be made until the area has been thoroughly ventilated.

System Description

Areas Protected

The CO_2 cylinders are located in a dedicated compartment on the starboard side of A deck in the engine casing adjacent to the emergency generator room. There are nine bottles in total each with a CO_2 content of 45kgs. The system is connected via a high pressure manifold and distribution pipework to the emergency generator room and the main switchboard room. The outlets for the CO_2 are located in order to give an even spread of gas quickly throughout the compartment when the bottles are released. A pressure gauge and pressure switch are fitted to the main CO_2 manifold. When the release system is activated for a particular protected space, only the required number of cylinders for that space are released.

Protected Space Number of Cylinders Required

Emergency generator room: 2
Main switchboard room: 7

Control Cabinets

Discharge of the CO_2 is manually accomplished from one of three control cabinets located on board. Two are located outside of the CO_2 locker and operate the emergency generator room and the main switchboard room bottles respectively and the third is located near the main

switchboard room entrance facing the main engine and it operates the bottles for that room only.
The system is operated by a supply of CO_2 stored in small pilot cylinders installed within the control cylinder cabinet. The pilot cylinders are connected to the main pilot system pipework via two isolation valves installed within the control cabinet.
One isolation valve is connected via small bore pilot gas pipework to the cylinder bank to open the cylinders while the other is connected via a separate pilot gas line to open the line valve to the protected space. The isolation valves are positioned so that the control cabinet door cannot be closed with the valves in the open position. It is also arranged that the control cabinet door will operate switches when in the open position, to initiate audible and visual alarms. An alarm panel for the system exists and is located in the main switchboard room. The alarm panel senses pressure rise and hence leakage from the main bottles and also senses pressure in the pilot lines if the system has been operated. It is from this cabinet that the compartment alarms are controlled and also the fire dampers for the main switchboard room operated.

PART 5 - REFERENCES

Hyundai MAN and B&W Manuals for Low Speed Engine 6L35MC

Alfa Laval – Fresh Water Generator JPSW-26 C100

Alfa Laval – LO/FO/DO Purifiers MOPX-MFOX

VSHIPS MANAGING SYSTEM

ABS CLASS information